The Monthly Review

Published by the AMERICAN ELECTROPLATERS' SOCIETY

AUGUST 1939

A. M. Baker.

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The Principle of Copper-Oxide Rectification

Construction of the Complete Rectifier

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The Monthly Review

Published by the AMERICAN ELECTROPLATERS' SOCIETY, Inc.

A Society for the Advancement of the Science of Electroplating

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The MONTHLY REVIEW

Published by the
AMERICAN ELECTROPLATERS' SOCIETY, INC.

Publication and Editorial Office
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VOL. XXVI AUGUST 1939 NO. 8

Editorial

This is **your** magazine. It is almost unique in that it has no stockholders and is actually the property of the subscribers.

It is not intended to be a profit making enterprise. On the other hand, the customary revenue from sale of subscriptions is lacking. While the national society would come to the rescue of the REVIEW, if there were a deficit, actually it is managed to come as near to breaking even as possible, with advertising the sole source of revenue.

We believe that the REVIEW has shown a steady improvement as the years have gone by, but we are well aware that there is plenty of room left for further improvement. We think that the change incorporated a year ago to furnish each member with printed copies of all convention proceedings, leaving the pages of the REVIEW free for other material, opens up great opportunities.

We would like to make the REVIEW a magazine to which you would turn in preference to any other.

Unfortunately it takes money to put a magazine on that plane. There is only one source for that money, and that is **more** advertising.

As we stated in the beginning, this is your magazine, and it is to your interest to aid in securing that advertising. The money will be used to better the magazine.

One of the principal obstacles encountered in soliciting advertising for the REVIEW is the persistent statement of advertising managers that they never hear anything about the REVIEW from customers. Maybe that is just a stall, but if it is, don't let them get away with it.

Below you will find an alphabetical list of all advertisers in the REVIEW during the past year.

Abbott Ball Co.
Advance Polishing Wheel Co.
Alrose Chemical Co.
American Brass Co., The
Atlas Powder Co., Zapon Div.
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Matchless Metal Polish Co.

Divine Brothers Co.	**McAleer Mfg. Co.**
Egyptian Lacquer Co.	**McGean Chemical Co., The**
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Harshaw Chemical Co., The	**Paul Frank**
Heil & Co.	**Stevens, F. B. Co.**
Jackson Buff Corporation	**Storts Welding Co.**
Kocour Company	**Sulphur Products Co.**
Lasalco, Inc.	**Udylite Co., The**
Lea Mfg. Co., The	**United Chromium, Inc.**

U. S. Galvanizing Co.

They seem to have weeks in this country for everything from apples to zinnias. We are asking you to have a REVIEW month. We believe in being different.

Will you please cut out this list and take it to the office with you. During the next 30 days, every time a representative of any concern that sells you anything or wants to, comes into your office, show him that list.

If his concern is on it, tell him that you notice that it is, and if it isn't tell him that you also notice that. That is all that is necessary and it does not obligate you in any way. But let's make these advertising managers so conscious in the next month about the fact that the REVIEW is read, that they will never again make any cracks along that line.

It is to your eventual benefit, and we feel sure that you will help. We cannot prove our point without you. Please cut it out right now and put it in your pocket, so you will have it when the salesman comes in tomorrow. Thanks!

HONORARY MEMBERSHIP IN THE A. E. S.

A letter has been addressed to the Executive Board of the Supreme Society by a charter member of one of our large branches. He wrote as an individual member, and as one who has been active in the Society since its inception. Although not an officer of either the Branch or the Supreme Society at present, he still keeps in touch with what is going on. His letter follows:

"The society was organized for and still has for its reason for existence according to our constitution, "The object of this society shall be the improvement and dissemination of the Art and Science of Electrodeposition and all its allied arts; the development of a cooperative spirit of friendship and mutual assist-

ance among its members, and the increase of knowledge of those occupied in the numerous applications of Electroplating".

The society has now been in existence twenty-seven years, and it has been been very successful in every way. It has also done very well in sticking to the object of its organization, and I trust it will continue to do so in the future. And if it does this it will certainly be a wonderful asset to all of the plating industry.

The constitution on Honorary Membership on page 1, Article II, Section 3, is very clear and should be understood by all the members and especially by the executive board, but it is not quite as definite in specification as to qualifications for honorary membership as it might be or should be. I would therefore suggest here and now that the qualifications be made more specific.

I am herewith quoting the section of our constitution in full:

> "Honorary Members: Honorary membership shall be conferred by a majority vote of the Society in Annual Meeting upon those persons whose knowledge and services have added or will add to the welfare of the Society. Any Branch Society desirous of having any person elected to Honorary Membership in the Supreme Society shall submit the name of such person with the necessary information, to the Executive Board, a majority of which shall approve the application before presentation to the Supreme Society for election".

As it now stands it seems to be up to the discretion of the Executive Board as to whether or not a member who is proposed for the honorary membership by a branch society is qualified, which of course is a tough spot for the Board to be in, especially in that the section has no specific qualifications, or, in other words, not specific enough.

According to my interpretation of this clause, "upon those Persons whose knowledge and services have added or will add to the welfare of the Society", every member of any branch is eligible and qualified for Honorary Membership according to these specifications. As every one who has held an office or acted as a committeeman has been of service and in both capacities of qualification, I believe Honorary Membership should be conferred only upon some "member" who has done something *out of the ordinary* for the Society as a whole, or, in other words, some outstanding service to the Society. If we do not check into this matter and make it a real honor to be conferred, it will become even cheaper looking than it now seems to be.

Of all the Honorary Members of the Supreme Society there are in my opinion only three who have really earned this by having done some outstanding service for the plating industry and the Society as a whole and not simply because they have done a good job of having held office in the Supreme Society or done some special job in a local branch. The 1938 Revision of the Constitution and By-Laws makes no provision for Honorary Branch Membership but it should be the privilege of each branch to have as many of its members "Honorary" in its own branch, but this should not entitle them to being Honorary Members of the Supreme Society. I think that any branch proposing a member to the Supreme honor, that that member should first have been an Honorary Member of that branch.

My suggestion is that an amendment to the constitution be made this year wherein a better qualification be specified for honorary membership into the Supreme Society. I am in favor of Honorary Membership but only on the qualifications of it really being an honor to the Society and not simply being an honor conferred to the individual as now seems to be the vogue."

CHARTER MEMBER

Note: Most of the members of the Board agree with the writer that more specific qualifications for honorary membership in the A. E. S. are necessary. (*Ed.*)

Educational Program

The success of our educational program depends upon several factors, most important of which are the men conducting the branch activities. All branches have been addressed for this information and the replies of those having answered are given herewith:

1939 EDUCATIONAL CHAIRMEN 1940

ANDERSON	R. M. Wagner	Anderson, Indiana, c/o Guide Lamp
BALT.-WASHINGTON	C. T. Thomas	1312-23rd St., S., Arlington, Va.
BING.-SYRACUSE	Austin Fletcher	108 Mason Ave., Binghamton, N. Y.
BOSTON	E. Jeveli	57 Crystal Cove Ave., Winthrop, Mass.
BRIDGEPORT	C. Helmle	44 Autumn St., Bridgeport, Conn.
BUFFALO	C. J. Wernlund	190 Christiana St., N. Tonawanda, N. Y.
CHICAGO	O. Weickman	2744 Pine Grove Ave., Chicago, Ill.
CINCINNATI	F. H. Nordman	1850 Northcutt Ave., Cincinnati, O.
CLEVELAND	R. O. Hull	9032 Broadway, Cleveland, O.
DAYTON	H. C. Leuchauer	19 Stockton Ave., Dayton, O.
DETROIT	A. B. Wilson	2056 Collingwood Ave., Detroit, Mich.
GRAND RAPIDS	Homer G. Morton	1743 Godwin Ave., Grand Rapids, Mich.
HARTFORD	Apley N. Austin	Pequabuck, Conn.
LOS ANGELES	E. R. Holman	6135 S. Central Ave., Los Angeles, Calif.
MILWAUKEE	H. Bornitzke	2602 N. 50th St., Milwaukee, Wis.
MONTREAL	H. S. Jordan	5282 Queen Mary Rd., Montreal, Que., Can.
NEWARK	Paul Oldam	90 Montgomery Ave., Newark, N. J.
NEW HAVEN	J. Sullivan	549 Savin Ave., West Haven, Conn.
NEW YORK	C. B. F. Young	Box 292, Flushing, Long Island, N. Y.
PHILADELPHIA	E. J. Zurbach, Jr.	1508 N. Newkirk St., Philadelphia, Penna.
PITTSBURGH	L. G. Marini, Jr.	1707 Fifth Ave., New Kensington, Pa.
PROVIDENCE	R. D. McLachlan	52 Waseca Ave., Barrington, R. I.
ROCHESTER	J. J. Desmond	20 Freemond Road, Rochester, N. Y.
SAN FRANCISCO		
SPRINGFIELD	D. Hartshorn	76 Edendale St., Springfield, Mass.
ST. LOUIS	J. Vogt	129 St. George St., Webster Groves, Mo.
TOLEDO	F. W. May	Electric Auto-Lite Co., Toledo, O.
TORONTO	J. Acheson	47 Abbott Ave., Toronto, Canada
WATERBURY	E. Couch	16 Cherry St., Waterbury, Conn.

Next in importance is the use made of the facilities represented by these men and it behooves everyone likely to be interested, to file this list in an easily accessible place for future reference.

All speakers should have these names and addresses for making advance arrangements; members for requesting programs desired by them in writing; and any outside the organization can make direct contact in the proper place for educational activity by addressing them.

Now as to the duties of these men in the larger sense other than the regular ones of supplying meeting and entertaining speakers and those of the meeting night procedure.

In the first place, any speaker of known interest should be referred to the supreme chairman who will endeavor to make his talk available to other branches.

Secondly, those chairmen in geographical sections such as Ohio, the New England area, northern New York State and Canadian branches, should confer on the possibility of adapting their meeting nights and speaker schedules so as to allow an individual to appear before them on successive days in one trip, thereby saving expense and time for the sponsor, or the branches; as the case might be. Considerable prearrangement of this nature has already been done for this year by some branches, which is very gratifying to your supreme chairman, while in many cases by closer cooperation among the local educational chairmen much more can be done.

Thirdly, the subject matter desired must come from the branch membership, and while bright copper and bright nickel were by far the most frequently requested subjects last season, their possibilities are so well known by now,

that newer material will probably replace them in popularity; so that the chairmen should closely contact the membership and report on those subjects most desired.

Failing such widespread demand for any one item, a more general program based on raw material specification, pre-plating treatments, costs and other subjects closely allied to plating practice have been found to be timely and of assistance in broadening our mental horizons beyond the edges of our plating tanks.

Since practically all solutions in every-day use are in their most efficient forms, proprietary in constituents, there is little to be learned gratuitously from their suppliers; other than the operating characteristics which have been thoroughly covered in the abstract section and by previous papers, and it is for this reason that the suggestion to branch out on other subjects than solution maintenance is made.

Suggestions for additional work of this nature will be much appreciated, especially if accompanied by the names of individuals competent to address our branches upon them.

The abstract section will be conducted by practically the same personnel as last year, with minor changes as listed below:

PERIODICALS

Abrasive Cleaning Methods — F. K. Savage
Acta Physics (U. S. S. R.)
Automotive Industry — R. M. Wagner
Applied Physics — J. T. Rooney
American Machinist
Aluminum
Bulletin Societie Francais Des Electriciens (France)
Bulletin, The (Coleman & Appleby, England) — John Broome
Ceramic Industry — J. T. Rooney
Chem. and Met. Engineering — D. S. Hartshorn, Jr.
Comptes Rendus (France) — J. T. Rooney
Chemistry and Industry
Die Metal Waren Industrie Und Galvano Technik (Germany) — Walter Meyer
Engineering (England)
Galvano (France) — C. T. Thomas
Industria Mechannica (Italian) — Charles Favetta
Industrial Finishing — F. K. Savage
Iron and Coal Trade Review
Iron Age
Journal Soc. Chemical Industry
Journal Ins. of Metals
Journal Electro Depositors Tech. Soc. (England) — N. E. Promisel and Abner Brenner
Korrison Und Metallschuts (Germany)
Mitteilungen Des Forschungsintituts Und Probieramuts Für Edelmetalle — N. E. Promisel
Metal Industry (England) — Abner Brenner and N. E. Promisel
Metal Industry — Edmund Jeveli and Paul Oldam
Metal Progress — J. F. Calef
Mill and Factory
Metals and Alloys — D. S. Hartshorn, Jr., and Phil Ritzenthaler
Machinery — R. M. Wagner
Modern Machine Shop
Oberfl Achentecnik (Germany)
Product Engineering — R. M. Wagner
Products Finishing — Edwin Lacy and Phil. Ritzenthaler
Revue De Metallurgie — N. E. Promisel
Steel
Sheet Metal Industry
Testo-To Hagane (Japan)
Trans. Faraday Soc. — Abner Brenner
Zeitschriff Für Metallkunde — N. E. Promisel
Zeitschriff Für Elektrochemie Etc. (Germany) — Walter Meyer
Trans. A. S. M. — J. F. Calef
Journal Industrial & Engineering Chemistry — J. F. Calef
Trans. Electro Chemical Soc. — Ernest Lyons, Jr.
Deutches Bunsen Gesellschaft (?)
Chemical Abstracts of American Chemical Society — Ernest Lyons, Jr.

Volunteers are requested for any open publications above or additional ones not listed, but received by some member, as well as suggestions for further enhancing the value of this committee's work.

In conclusion, any credit for the past year's increased activities in educational and abstract work is due entirely to the membership of the educational and abstract committees and their careful selection by the local branch officers and not to the nominal head of these groups, and therefore I wish to take this opportunity of thanking all those taking part in our past year's program for their splendid cooperation and extend the wish that by even more earnest endeavor this coming year, we may exceed our utmost expectations.

FREDERICK FULFORTH

Mr. W. W. McCord of Detroit Branch has been appointed Associate Editor of the MONTHLY REVIEW. Mr. McCord will solicit advertising in the Detroit area and will help in the editing of the REVIEW.

W. J. R. KENNEDY,
Editor

The Lea Manufacturing Company, Waterbury, Connecticut, have made an arrangement with United Chromium, Incorporated, for the use of "Unichrome" Rack Coating-W to insulate plating racks.

"Unichrome" Rack Coating-W is a new and improved rack coating material which had been developed by United Chromium, Inc. It is a white insulating material which has outstanding properties of resistance to plating and cleaning solutions. "Unichrome" Rack Coating-W combines elasticity and tensile strength with toughness and resistance to abrasion. It is not affected by chromium or other plating solutions.

The Lea Manufacturing Company has had several years experience in insulating plating racks for manutacturers, and have a special department fully equipped for dipping, drying and immersion of plating racks. This equipment is the most modern obtainable, using electrical heating units thermostatically controlled. They are in a position to give prompt and efficient service to manutacturers, especially in New England and New York States.

$50.00 PRIZE AWARD

A prize award of $50.00 will be given to the author of the best paper written for publication in the REVIEW from now until the end of the fiscal year.

Practical papers of interest to the membership are preferred. Any member of the A.E.S. may compete.

All articles should be mailed to the Executive Secretary and should reach us before the 12th of each month.

Research Committee

To the various Branches and to the individual members of the various Branches.

Gentlemen:

This year the most important work with which your Research Committee has been charged is to find a suitable program for future work, one which will be of interest and value to the electroplating industry. To this end the Committee is appealing for advice and suggestions from each and every one of you.

In the past some of you have felt that the particular things in which you were interested have not been investigated. That may have been so as obviously it is not possible to cover the specific needs of every one. However, this year every one of our members is being given the opportunity to voice his opinion before anything new is undertaken.

There will be a meeting of the Research Committee about the middle of October and in the interval before that meeting there will be at least one or two meetings of each Branch. We ask that the president of each branch bring the research program up for discussion at these meetings and forward to the Committee any suggestions or criticisms you may care to make. These may be sent to any member of the Committee, the names of whom appear in the August REVIEW. Suggestions from individual members will also be given full consideration

Remember in making these suggestions you are not limited in any way. If you have any constructive ideas we want them.

This letter is being sent to each Branch Secretary. It is also being published in the REVIEW. Therefore, there is no reason why any member should not be familiar with its contents.

"It is the desire of the committee to have the full co-operation of the society membership as individuals or through its branches in arriving at a desirable program. Please, therefore, give us the benefit of your ideas, suggestions and criticisms as soon as possible, and not after everything is set to go. It is to be your program, the Research Program of the American Electroplaters' Society.

Yours very truly,
A.E.S. Research Committee
A. B. WILSON
Chairman, 2056 Collingwood Ave., Detroit, Michigan

The Research Committee for the current year will consist of the following men:—

Mr. A. B. Wilson	Chevrolet Motor Co.	1901 E. Euclid, Detroit, Mich., *Chairman*
Mr. E. A. Anderson	New Jersey Zinc Co.	Palmerton, N. J.
Dr. William Blum	Bureau of Standards	Washington, D. C.
Mr. E. T. Candee	American Brass Co.	Waterbury, Conn.
Mr. C. E. Heussner	Chrysler Corp.	12800 Oakland Ave. Detroit, Mich.
Mr. F. J. MacStoker	Sperry Gyroscope Co.	Manhattan Bridge Plaza Brooklyn, N. Y.
Mr. B. H. McGar	Chase Brass & Copper Co.	Waterbury, Conn.
Mr. F. C. Mesle	Oneida, Ltd.	Onieda, N. Y.
Mr. T. F. Slattery	Bureau of Printing & Engraving	Washington, D. C.
Mr. Erwin Sohn	American Radiator and Standard Sanitary Corp.	Louisville, Ky.
Mr. E. S. Taylorson	Carnegie-Illinois Steel Co.	210 Semple St., Pittsburgh, Pa.

The A.E.S. Members of the Joint Committee with the A.S.T.M. will be:—

Mr. E. A. Anderson
Mr. E. T. Candee
Mr. B. H. McGar
Dr. W. A. Wesley — International Nickel Co. — Bayonne, N. J.
Mr. A. B. Wilson

Please address communications regarding the research work to any one of the above with whom you prefer to work.

A LETTER FROM THE PRESIDENT

A little over two months have passed since the convention. In this short time I feel that a great deal has been accomplished that will meet with your approval.

When you receive the September number of the REVIEW you will be agreeably surprised with its new appearance. Mr. Kennedy, our Financial Secretary and Editor, has worked out a plan whereby the front cover advertising has been removed without loss of revenue to the A.E.S.

I am asking you in his behalf to assist in the advertising campaign that is now being carried on. The supply houses would like to know if they are getting value received for the money they are spending for advertising. You can give them this information by mentioning the MONTHLY REVIEW when buying your supplies from them. I am sure this is not asking too much and Mr. Kennedy would greatly appreciate this assistance.

During the coming year we will endeavor to improve the reading material in the REVIEW. To do this we must obtain articles that are clear and concise and of interest to our membership. Many of the members of our Society are capable of writing such papers. It is therefore my intention to ask our membership to take part in a contest that will bring about the results we desire. We are offering a prize of $50 for the best paper published from now until the convention at Dayton. An awards committee of five will be appointed and their decision will be given at the final business meeting of the convention. Send your papers to the Editor of the MONTHLY REVIEW.

R. M. GOODSELL, *President*

THE PLATERS' FALL OUTING AT BOB LEATHER'S

All men in the Plating Industry are invited to Leacrest, the home of R. S. Leather, President of the Lea Mfg. Co. Waterbury, on Saturday, October 7. No special invitations are being issued. All who wish may attend. Further details in next month's REVIEW.

The following members have been appointed to act as the Papers Awards Committee.

Dr. C. B. F. Young, *Chairman*
Joseph Haas, New York Branch
Paul Oldam, Newark Branch
D. S. Hartshorn, Springfield Branch
F C. Mesle, Rochester Branch

A Study *of* Silver Plating *for* Industrial Applications

EDITORIAL ABSTRACT

The authors present the results of investigations relating to industrial applications of silver plating. Methods of porosity testing are discussed and compared. Some effects of (a) the surface quality of the basis metal, (b) undercoats of copper and of nickel, and (c) forming operations on the porosity of the deposits are reported. The application of these studies to the development of silver-lined containers, such as cans and barrels, is discussed.

1. INTRODUCTION

*A. J. DORNBLATT**
*C. S. LOWE***
*A. C. SIMON***

Paper read at the A. E. S. Convention at Asbury Park

THE advantage of silver linings in containers to protect the contents against contamination is suggested by the well-known corrosion-resistance of silver to foodstuffs and beverages. The acceptance of silver for hundreds of years for tableware and its inertness toward organic acids, caustic alkalies, and certain dilute mineral acids are evidences of its suitability for handling a wide variety of products.

Solid silver equipment is used in those chemical industries where the durability and high scrap-value of silver justify the initial investment. A broader application of silver would result if its corrosion-resistance could be utilized at a low cost. Hence, it was natural that in seeking new industrial uses for silver the research staff of the American Silver Producers' Research Project should give consideration to the development of containers lined with silver. There is a large field of usefulness for silver-lined containers of two rather distinct types. One is a container that would justify an appreciably high first cost, such as would necessarily be involved if the silver had to be thick enough to withstand abrasion and to have a long service life. Returnable shipping containers, such as barrels, may be so classified. The other kind of container is a single-use, non-returnable type. Such a container would have to be inexpensive, which would be possible

*Senior Research Associate, American Silver Producers' Research Project, Washington, D. C.
**Research Associates, American Silver Producers' Research Project, Washington, D. C.

only if the silver lining were very thin and the service conditions involved no appreciable attack or abrasion of the silver.

At the present time there are two commercial methods by which the benefits of silver can be obtained without the cost of solid silver construction. Both of these are employed in the manufacture of equipment used in the chemical industry. In one method, sheet silver is used as a mechanically inserted lining; in the other, the equipment or container is fabricated from silver-clad metal produced by rolling down a composite slab or ingot of silver and another metal such as steel, nickel, or copper. The use of such methods rests on the assumption that a relatively thick silver lining is required and economically justified. While such linings can be produced with a thickness of silver of a few thousandths of an inch, they are more usually some hundredths of an inch thick.

In an effort to develop silver-lined containers with thinner coatings than could otherwise be commercially produced, the authors investigated electrodeposited coatings with thicknesses up to a few thousandths of an inch. They were confronted with two problems, the study of which produced the data reported in this paper. One problem was the production of silver deposits free from any porosity whatsoever on a flat steel basis up to approximately five square feet in area. For commercial reasons, this pore-free deposit could not be substantially greater than .001 inch in thickness*. The other problem was to determine, if possible, the *minimum* thickness of silver that could be produced free from any porosity.

Some of the plating studies undertaken in investigating these problems, particularly those dealing with the relation between the thickness and the porosity of the coatings, are reported in this paper. These studies have been of value in the trial production of barrels formed from plated steel and in the preparation of thin silver linings for certain single-use non-returnable cans. The production of containers of these two types is now being studied by manufacturers of barrels and cans in cooperation with the Project staff.

*At the open market price (July 12, 1939) for silver, $5.10 per avd. pound, this thickness of silver represents a metal value of approximately 28 cents per square foot.

2. METHODS OF TESTING POROSITY

One obstacle to the commercial development of silver-lined containers has been the lack of definite information regarding the porosity of electrodeposited silver and the possibility of producing relatively thin silver deposits free from pores. In general, silver would not be used if a cheaper metal were equally suitable. Therefore the silver coating should be pore-free, so as not to expose the basis metal, which might be attacked at an accelerated rate because of the galvanic action between it and the more noble (cathodic) silver, and might impair the quality of the contents.

In this investigation, an effort was made to define the conditions for producing a pore-free deposit, rather than to analyze the causes of porosity. While the two points of view are connected, the limited time available necessitated an empirical approach to the problem. Therefore, these studies are not complete or final with respect to the porosity of silver deposits. In general, the experience of the authors confirms the scholarly analysis of the causes of porosity of electrodeposited metals presented by Hothersall and Hammond ([1]) ([4]) in their study of the porosity in electrodeposited nickel coatings.

Little has been reported on the porosity of silver deposits, so it was necessasy to study the applicability to silver coatings of existing tests for porosity. Three methods were considered for testing coatings on steel: the ferroxyl, the salt spray, and the hot water tests.

(a) The ferroxyl test ([4]) ([5]) makes use of an aqueous solution of sodium chloride as a corroding medium. The ferrous ions thus brought into solution react with the ferricyanide present in the test solution to form a ferrous ferricyanide, Turnbull's Blue. The test solution may be applied by means of paper impregnated with the reagent, or as a gelatin solution which congeals and, by preventing diffusion of the corrosion products, localizes the blue precipitate at the pore in the deposit. In 1934, Strausser, Brenner, and Blum([2]) found that this reagent attacks nickel appreciably at the concentrations previously employed, and proposed the use of a more dilute reagent, containing 60 g/l of sodium chloride and only 0.5 g/l of potassium ferricyanide.

In this work it was found that even this dilute reagent attacks silver, producing pin-hole perforations in fine silver foil .001 inch thick within thirty minutes.

It was evident that since the dilute ferricyanide solution attacks silver appreciably, the ferroxyl reagent, as ordinarily used, is not suitable for testing the porosity of very thin silver coatings, because it might indicate porosity where none existed before making the test. To eliminate attack by the ferricyanide it was suggested by P. W. C. Strausser, as presented in his paper to this convention([5]), that the test paper be impregnated with the sodium chloride solution only and, after having been applied to the electroplated specimen, it be immersed in a ferricyanide solution, to develop blue spots where the test paper had absorbed iron salts through the pores.

This test is referred to in this paper as the "print modification" of the ferroxyl test. Unless otherwise noted, the ferroxyl reagent used in this paper is made as recommended in reference 2. When the test was made with a gel, it is spoken of as the ferroxyl gel test; otherwise, as the ferroxyl-impregnated paper test.

(b) In the salt spray test, the specimen is exposed in an inclosed space to a fine mist of sodium chloride solution. On very thin, porous coatings this test was of little value, because the rust was so widespread that individual pores could not be counted.* On thicker coatings with low porosity, the number of pores detected was comparable with, but slightly less than, the number revealed by the ferroxyl test. Owing to the time and equipment involved in extensive salt spray tests, they were discontinued after their general correlation with the other tests had been established.

(c) The hot water test used in these studies was that described by Macnaughtan, Clarke and Prytherch([3]). The degreased specimens were heated in distilled water at 90-95°C for three hours and allowed to remain in the water, as it cooled, for at least 18 hours longer. The rust spots developed in this test could be readily counted.

The composition and surface finish of the various basis metals used in the tests reported in this paper are given in Table I.

*There is reason to believe that, under the conditions of this test, some silver is dissolved.

Three of the steels were selected for plating studies reported in Table II.

TABLE NO. I
Basis Metals Used in Plating Studies

Lot	Composition						Remarks	U. S. S. Gauge
	C	Mn	P	S	Si	Cu		
1	.05	.37	.007	.013	.01*		Flange quality deep drawing steel. Hot rolled, pickled finish	18 (.05")
3	.09	.32	.007	.031	.01*		Low carbon steel. Cold rolled, satin finish	22 (.030")
4	.07	.41	.010	.027	.01*		Commercial can stock of deep-drawing quality. Mill finish.	(.0.12")
5	.05	.30	.015	.026	.01*		Low-metalloid, rimmed open-hearth steel. Cold rolled bright finish. Automobile body stock.	33 (.009")
7	.10 max.						Low carbon steel, cold rolled by polished tungsten carbide rolls. Mirror-finish.	33 (.009")
8						99.98	Oxygen-free, high conductivity copper. Polished to a mirror-finish.	30 (.0125")

*Less than

3. COMPARISON OF POROSITY TEST METHODS

The porosities of silver deposits on three different steels, as determined by the ferroxyl paper, ferroxyl print, and hot water tests, are given in Table II.

TABLE NO. II
Comparison of Porosity Test Methods

Basis Metal Lot No.	Silver Deposit inches	Porosity. Ferroxyl, paper Method	Pores/dm². Ferroxyl, Print Modification	As Determined By Hot Water Test
7	.0001	612	187	66
5	"	*	635	86
4	"	*	850	290
7	.0005	10	12	10
5	"	6	6	0
4	"	15	8	1

*Pores too numerous to count

It is difficult, if not impossible, to duplicate porosity counts in independent experiments with relatively porous deposits. The figures given here and in later tables are of interest and value only for their relative order of magnitude. Thus with 0.0005 inch

of silver (Table II) all three methods of test should be considered to indicate substantially the same order of porosity of coatings on the three steels. Similarly, the curves presented in Figures 3, 4, and 5 are significant primarily for the trends which they indicate.

With 0.0001 inch of silver deposited, the pore count with the ferroxyl paper was higher than with the print method, and that with the hot water test was the lowest. As discussed below, in connection with data presented in Table V, the hot water test may under other conditions indicate a higher porosity than does the print method.

Reference to Table V for silver deposits over nickel undercoats may be made at this point for data to be used in comparing porosity test methods. Columns A and D give the pore-count obtained with the ferroxyl print method on two samples from the same plating bath. Column B gives the pore-count by the ferroxyl paper method, yielding a higher count than in Columns A and D. The scattering in duplicate tests is evident when one compares the data of Columns A and D; or of Columns G and H, which represent pore counts on two sides of the same specimen.

It might be concluded from the data of Columns G and H that one surface of the large sheet from which the 12 x 12 inch specimens were cut differs in quality or condition from the other surface and that the plating on the surface of poorer quality is responsible for the higher pore count noted when comparing porosity of the front and back sides. Strausser([5]) cites data indicating that, as a result of some variable in steel mill practice, there may be a difference between the front and back of commercial rolled sheet which causes the deposit on one side to be more porous than that on the other side. Hothersall and Hammond([1]) have demonstrated that, in the presence of suspended matter in the electrolyte, more porous deposits are obtained on surfaces slightly inclined to the vertical and facing upwards, owing to particles which settle out preferentially on such favorably disposed surfaces. Experiments by the authors made after the work reported herein was completed have confirmed this fact. In the work reported here, the authors failed to differentiate between the front and back of the sheet steel used, and in interpreting their results,

both of these possibilities must be considered in connection with the scattering in duplicate tests. Other results reported in this paper on the effect of surface quality (Table III) indicate that differences more pronounced than were observed visually between the two surfaces of steel No. 5 would not account for such variations in porosity as noted in Columns G and H.

Column F of Table V shows that the ferroxyl gel test indicates excessive porosity of nickel deposited on steel (with no silver) even when the nickel thickness is 0.001 inch. This is an indication that the gel containing ferricyanide attacks nickel severely, Hothersall and Hammond([1]) and also P. W. C. Strausser([5]) have shown that successive tests on a given nickel-plated specimen with the ferroxyl paper tend to give increasing porosity counts, which indicates attack of the nickel by the ferricyanide. If, however, the print method is used, successive porosity counts made on the same specimen show no increase in pores. Columns D and E of Table V test results of successive tests by the print method of the same specimens. That some sealing of pores may result from the application of the print method is indicated by the generally lower pore count obtained when the second test is made upon the same area.

The results obtained with the hot water test (Columns G and H) present certain complications, possibly caused by differences in galvanic action, to which reference is made later in this paper. When the deposit is both thin and porous, and galvanic corrosion is possible, this test, as in Table V, appears to give a higher pore count than does the ferroxyl paper and ferroxyl print tests. These last named tests involve exposure of the specimens for a much shorter time than does the hot water test.

To sum up, it may be stated that of these various methods the hot water test is least open to suspicion of attacking very thin silver deposits (0.0002 inch and less), and its results bear some direct relation to what might be expected in an open container filled with an aqueous solution. However, the ferroxyl print method is quicker and probably satisfactory enough for most practical purposes. If no pores are indicated by either the ferroxyl gel or ferricyanide impregnated paper, it may be assumed, unless service tests prove to the contrary, that the deposit is pore-free with

respect to the basis steel. The appearance of pores is not necessarily a proof that all the pores existed before the test was made.

4. FACTORS AFFECTING POROSITY OF SILVER COATINGS

Since little information could be obtained from the literature or from commercial silver plating firms regarding the porosity of electrodeposited silver, preliminary experiments were made with ordinary plating methods to determine the relation between porosity and thickness. Four by six inch specimens of a low-carbon, deep-drawing steel (lot 4 of Table I) were degreased, cleaned cathodically, pickled in 2 N hydrochloric acid at room temperature and then silver plated. The two silver strikes and the silver plating solution for white deposits were prepared according to formulae given by Blum and Hogaboom.([6]) With the ferroxyl paper, low porosity values were obtained with coatings 0.0005 inch or more in thickness.

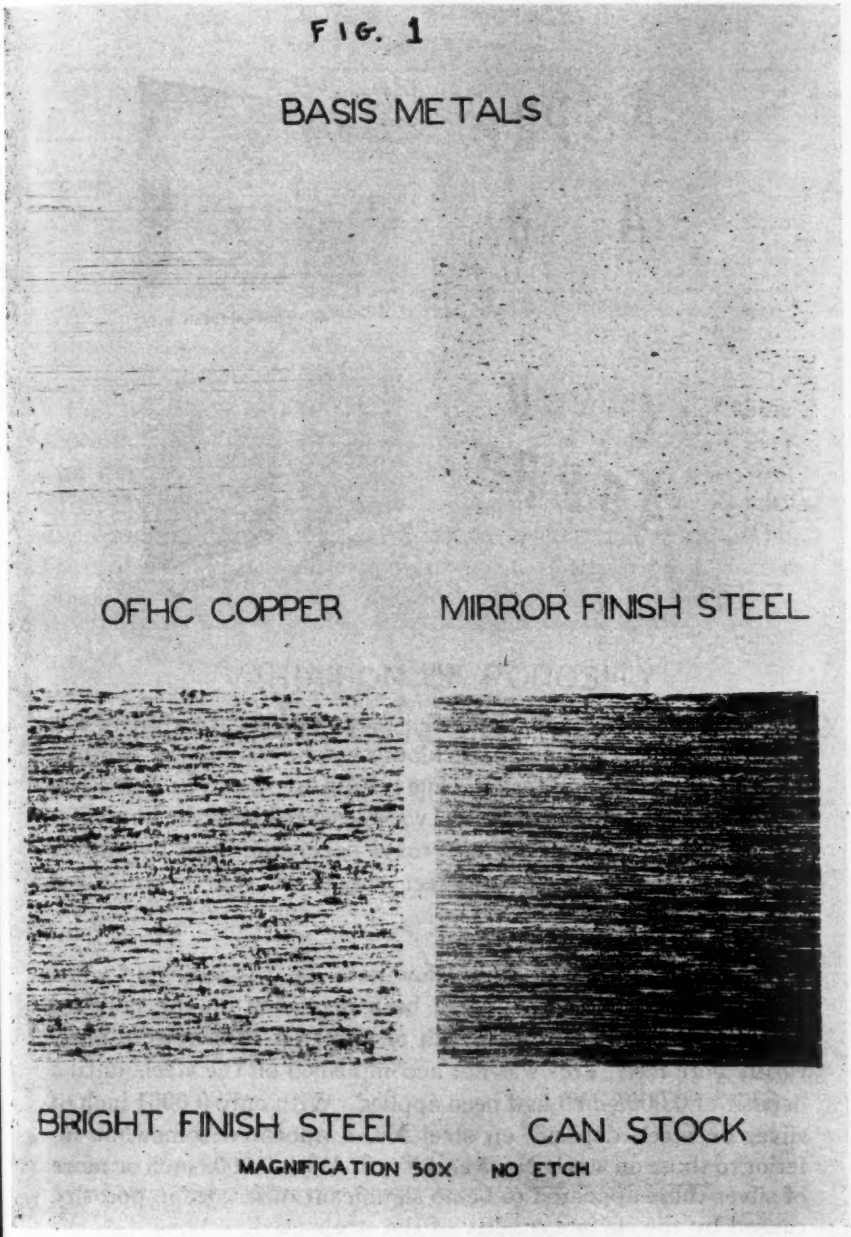
Normal variations in cleaning, pickling, degree of agitation, current density, and temperature had no significant effect on the approximate thickness required for pore-free deposits. Over-pickling caused increased porosity. With a proprietary brush-plating paste as electrolyte and an anode brush for plating, pore-free deposits were obtained with 0.0002 inch of silver. That this method of plating is capable of producing pore-free deposits thinner than those from the regular cyanide bath on the same basis metal was noted by L. I. Gilbertson in researches conducted at Indiana University in 1937.([7])

In the subsequent plating of a large number of steel circles for use in forming experiments it was found *necessary* to maintain the plating bath free from suspended solid matter in order to obtain pore-free coatings 0.001 inch thick. Filtration, the addition of only filtered solutions, bagging of anodes, and avoidance of extraneous contamination are necessary precautions.

To determine the effect of surface quality of the basis metal on porosity, deposits were made on low-carbon steel having four different finishes, and also on polished oxygen-free copper. The surface conditions of the copper and three of the steels are illustrated in Fig. 1 and 2.

FIG. 1

BASIS METALS



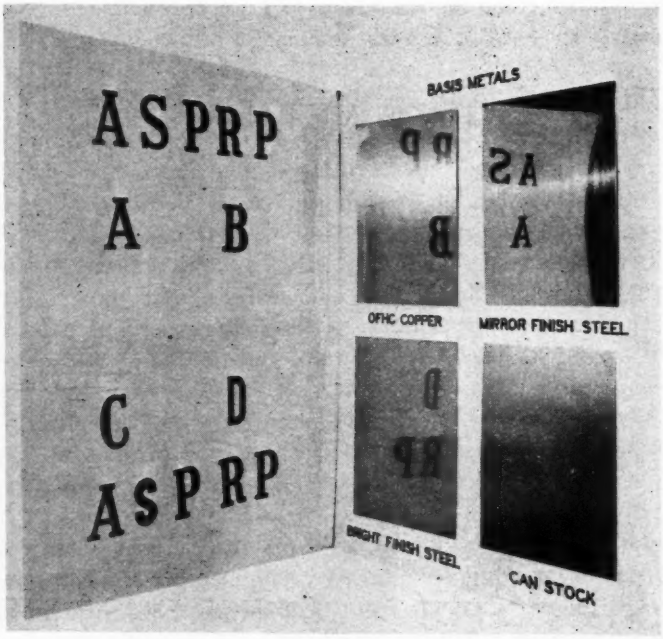


FIG. 2

To avoid alterations of the finish, no pickling treatment was used. After degreasing in trichloroethylene vapor, the samples were silver plated and tested. The results are shown in Table III. The porosity of coatings on steel was measured with the hot water test and on copper with the ferroxyl paper, modified by adding potassium ferrocyanide to detect copper as the brownish-red copper ferrocyanide.

Table III shows that a very low porosity was indicated when only 0.00001 inch of silver had been deposited on the polished copper. Deposits of 0.0001 inch of silver on copper were practically pore-free. This was not accomplished on the steels until a deposit of 0.0005 inch had been applied. With only 0.0001 inch of silver on steel, deposits on steel No. 4 appeared somewhat inferior to those on steels No. 5 and No. 7. With 0.0002 inch or more of silver there appeared to be no significant difference in porosity caused by the surface quality of the steels used.

TABLE NO. III
Variation of Porosity With Surface Quality of Basis Metal Porosity*, Pores/Dm²

Silver Deposit (inches)	Mirror Finish, Steel No. 7	Satin Finish, Steel No. 3	Bright Finish, Steel No. 5	Mill Finish, Steel No. 4	Mirror Finish, Copper No. 8
.00001	**	—	**	**	12
.0001	66	—	86	290	1
.0002	100	67	72	96	0
.0005	10	4	0	1	0
.001	3	0	0	9	0

*Hot Water Test used on steel samples, Ferrocyanide impregnated paper used on copper samples.
**Too numerous to count.

Fig. 3 shows the relation of porosity and thickness of silver deposits on two different basis metals. The porosity of very thin deposits varies with the surface quality of the steel, but on the basis metals studied no significant difference in porosity was observed in coatings as much as 0.0005 inch thick. This figure also illustrates the less porous nature of the brush-deposited silver.

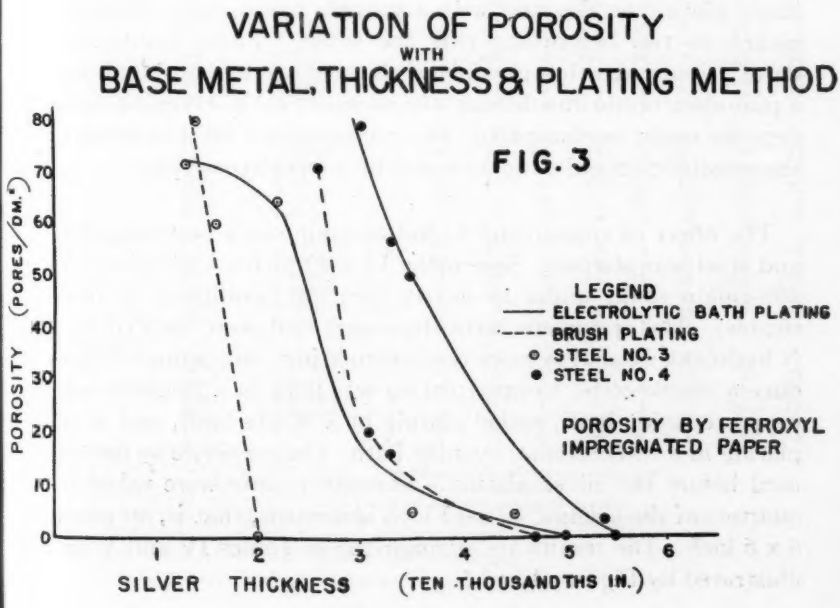


Table II shows that the steel of rougher finish (No. 4) yielded a greater porosity for thin deposits. The sudden decrease in porosity commonly noted for various types of electrodeposits, as the thickness of the deposit is increased, may be related to a critical condition that is characteristic of each basis metal or of its surface quality. Perhaps when the surface irregularities approach or exceed in magnitude the thickness of the deposit, the porosity is aggravated. Porosity may also be caused by non-metallic inclusions in the basis metal, upon which the metal in the electrolyte cannot deposit, but over which the deposited metal crystals eventually bridge. Of all the basis metals studied, the cleanest, most homogeneous microscopically was the oxygen-free copper. From the authors' laboratory results as well as those of other workers in obtaining pore-free deposits .0001 inch thick it appears theoretically possible to obtain on a suitable "ideal" basis metal pore-free deposits of nickel, silver, and probably of other metals, less than 0.0001 inch thick.

The most readily available basis metal of high purity and homogeneity is electrodeposited metal, the surface finish of which is itself relatively smooth and uniform. For containers this would imply plating on the steel with a suitable metal, such as copper, nickel, or tin, before applying the silver. From Hothersall's data([1]) it appears that possibly, if the steel were first coated with a pure electrolytic iron deposit, the necessity for intervening metal deposits might be eliminated. Due consideration must be given to the possibility of galvanic corrosion in composite coatings.

The effect of copper and nickel as undercoats between silver and steel was studied. Specimens 12 x 12 inches were plated in 100-gallon tanks under as nearly identical conditions as practicable. The specimens were degreased and were pickled in 2 N hydrochloric acid at room temperature just long enough to produce a visible etch. Copper plating was done in a Rochelle salt-copper cyanide bath, nickel plating in a Watts bath, and silver plating in a conventional cyanide bath. Only a single strike was used before the silver plating. Porosity counts were taken on quarters of the original 12 x 12-inch specimens, that is, on pieces 6 x 6 inch. The results are summarized in Tables IV and V and illustrated by Figures 4 and 5.

TABLE NO. IV

Effect of Copper Undercoat on Porosity of Silver Electrodeposited on Steel No. 5

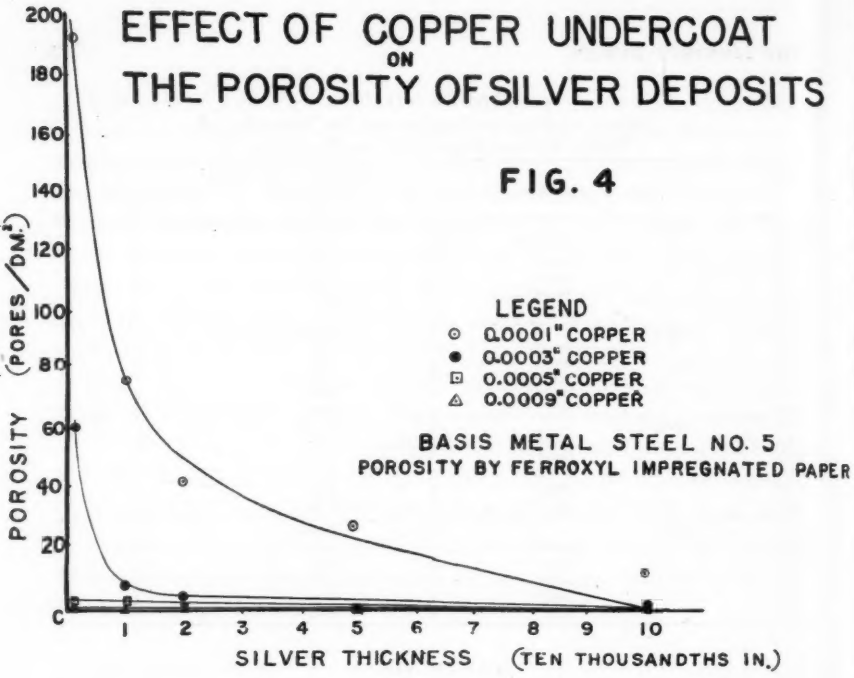
Mark	Copper Thickness	Silver Thickness	Porosity, Pores/Dm²		
			Ferroxyl Paper	Hot Water Test	Ferrocyanide Paper
B51	.0001"	----	70	84-28	---
B46	"	.00001"	193	4-4	1
B47	"	.0001"	77	2-1	0
B14	"	.0002"	41	4-3	0
B15	"	.0005"	29	12-8	0
B16	"	.001"	13	3-	1
B52	.0003"	----	8	7o-19	---
B45	"	.00001"	59	1--	22
B27	"	.0001"	7	1-0	3
B26	"	.0002"	5	2-2	0
B43	"	.0005"	0	0-0	0
B44	"	.001"	2	0-0	0
B53	.0005"	----	6	9-32	---
B42	"	.00001"	3	0-0	48
B22	"	.0001"	3	2-0	0
B38	"	.0002"	0	0-0	0
B39	"	.0005"	1	0-0	1
B21	"	.001'	0	1-0	0
B54	.0009"	----	0	0-10	---
B31	"	.00001"	1	0-0	26
B32	"	.0001"	0	0-0	0
B30	"	.0002"	1	0-0	1
B33	"	.0005"	2	0-0	1
B34	"	.001"	0	0-0	0

TABLE NO. V

Effect of Nickel Undercoat on the Porosity of Silver Electrodeposited on Steel No. 5

Nickel Thickness	Mark	Silver Thickness	Porosity (pores/dm²)							
			A	B	C	D	E	F	G	H
0.0001"	B59	No Silver	0	※	28	32	20	※	16	2
	B60	0.00001"	64	※	52	130	54	※	275	100
	B61	0.0001"	7	148	3	109	84	※	72	116
	B62	0.0002"	20	13	5	69	10	※	2	8
	B63	0.0005"	4	24	4	3	6	95	2	15
	B64	0.001"	20	1	0	0	2	22	4	6
0.0002"	B65	No Silver	15	5	1	0	3	※	10	3
	B66	0.00001"	44	※	87	79	20	※	48	45
	B67	0.0001"	16	72	21	60	13	※	250	225
	B68	0.0002"	2	13	6	18	12	15	14	27
	B69	0.0005"	0	3	0	1	11	13	13	4
	B70	0.001"	7	5	1	0	1	0	2	7
0.0005"	B71	No Silver	11	17	4	3	2	※	0	0
	B72	0.00001"	18	16	3	6	6	33	2	4
	B73	0.0001"	4	36	8	11	11	10	200	175
	B74	0.0002"	7	17	5	19	14	96	225	150
	B75	0.0005"	3	7	0	4	3	25	25	60
	B76	0.001"	4	1	0	0	1	1	6	13
0.001"	B77	No Silver	0	1	0	0	9	※	0	8
	B78	0.00001"	2	3	0	0	7	4	2	4
	B79	0.0001"	4	6	1	5	6	3	33	61
	B80	0.0002"	2	1	1	3	1	2	16	15
	B81	0.0005"	3	5	0	0	0	0	2	7
	B82	0.001"	2	4	0	0	6	1	0	0

A — Print method (salt only)
B — Ferricyanide impregnated paper —Test applied on same area and after A
C — Print method (salt only) — Followed test B, on same area
D — Print method (salt only) — Test made on another untested quarter
E — Print method (salt only) — Followed D — Test made on same area
F — Ferroxyl-gel test — Test made on different quarter
G — } Hot water test — Values for both sides of specimens
H — }
※ — Indicates that pores were too numerous to count


EFFECT OF COPPER UNDERCOAT
ON
THE POROSITY OF SILVER DEPOSITS
FIG. 4
LEGEND
0.0001" COPPER
0.0003" COPPER
0.0005" COPPER
0.0009" COPPER
BASIS METAL STEEL NO. 5
POROSITY BY FERROXYL IMPREGNATED PAPER
POROSITY (PORES/DM.²)
SILVER THICKNESS (TEN THOUSANDTHS IN.)

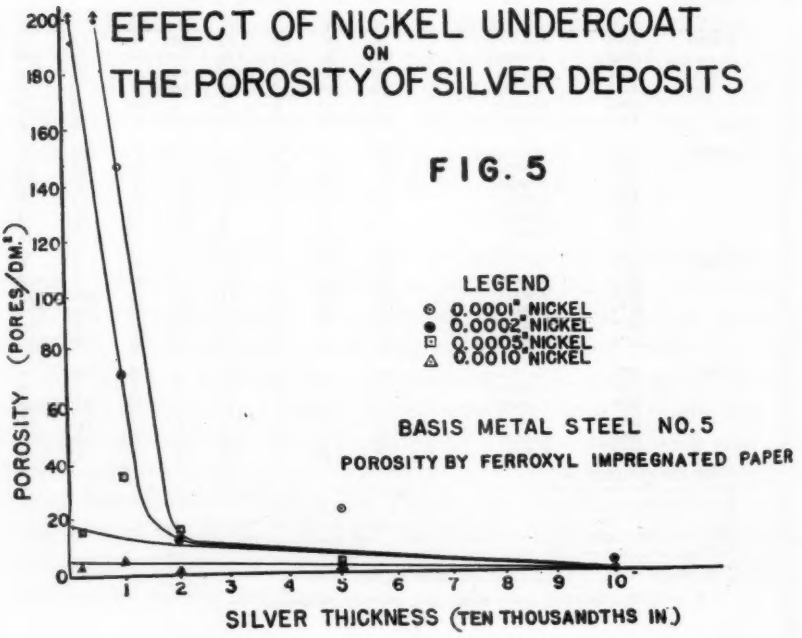

EFFECT OF NICKEL UNDERCOAT
ON
THE POROSITY OF SILVER DEPOSITS
FIG. 5
LEGEND
0.0001" NICKEL
0.0002" NICKEL
0.0005" NICKEL
0.0010" NICKEL
BASIS METAL STEEL NO. 5
POROSITY BY FERROXYL IMPREGNATED PAPER
POROSITY (PORES/DM.²)
SILVER THICKNESS (TEN THOUSANDTHS IN.)

Table IV, and Figure 4 plotted from it, indicate that, under the conditions of these tests, very thin silver deposits on a copper undercoating 0.0005 inch thick were substantially pore-free, both as to exposed copper or steel. On a copper deposit which was itself pore-free, less than .0001 inch of silver produced a coating that was pore-free to copper.

Table V, and Figure 5 plotted from it, indicate that a nickel undercoat was somewhat less effective than copper.

In these tests, porosity through to copper could be detected by the ferrocyanide reagent, but no effort was made to test for porosity of the silver with respect to nickel.

The hot water test, which is of much longer duration than the ferroxyl paper test, showed that where copper alone was deposited on steel (See Table IV) and the deposit was thin enough to be porous, a higher pore-count was obtained than by the ferroxyl paper method, presumably because of increased galvanic action between the steel and copper. In similar coatings of thin nickel deposits, the tendency toward galvanic action is much less and the hot water test did not show greater porosity than the ferroxyl paper method. (Compare columns G-H of Table V with column B). The potential of the galvanic couple (silver-steel) set up when a porous silver deposit is plated on a porous nickel deposit on steel is of course greater than that between nickel and steel alone, and may account for the apparent increase in porosity noted in Table V with the deposition of about 0.0001 inch of silver over thin nickel coatings. However, there is no apparent reason why this effect is not noted in the case of the 0.00001-inch silver deposit.

An independent check experiment failed to show any increase in porosity with the deposition of a very thin silver layer either on copper or nickel over steel. In this check experiment the nickel and copper deposits alone were found to be relatively free from pores. This may have prevented the effect which occurred in the first experiment. Evidently, reproducible porosities were not found on deposits as thin as 0.0002 inch or less.

This lack of reproducibility, it should be noted, is not only a function of the method of testing, but also of the quality of the basis metal and the technique of plating and testing. With thick-

nesses less than a certain critical value the surface quality of the basis metal becomes a controlling factor. Below this critical thickness, which seems to be a function of the surface quality of the basis metal, the porosity in general will increase very markedly, and concordant results are the exception rather than the rule. Fortunately, this is not of much practical importance, since the aim is to obtain coatings pore-free, or nearly so. For example, two coatings containing 250 or 500 pores per dm^2 would be equally useless for commercial purposes. While several steels were used in this work, they did not differ much in composition and they were all cold rolled. This may be the reason why the critical thickness of all of these samples is close to 0.0002 or 0.0003 inch. A much rougher surface finish, such as is produced by a deep scratch, will raise this critical thickness. On the other hand, the critical thickness of silver on the copper used in these studies is about 0.0001 inch or less.

5. APPLICATION OF THESE STUDIES

The results of these studies are being utilized in connection with two different types of containers now being developed. An effort is being made to develop a sanitary can suitable for foodstuffs and beverages of superior quality lined with not over 0.0001 inch of silver, which represents about one cent's worth of silver on a 12 ounce can. The second development is a barrel, lined with about 0.001 inch of silver, for handling beverages whose flavors are very sensitive to metallic contamination. Such a barrel may be competitive with aluminum and stainless steel barrels.

The cans under consideration have a seamless body formed from a steel such as that of lot No. 4. It is proposed to plate the body and flat sheet, from which the can ends can subsequently be formed. The data of Table IV indicate that a copper deposit of 0.001 inch would safely protect the steel from exposure to the contents of the can even if no silver is over the copper. As little as 0.0001 inch of silver on top of the copper provides a lining which completely prevents exposure of the steel and protects the contents of the container from contact with copper. As there is no serious galvanic action between silver and copper, a few pin holes in the silver deposit would be harmless, because the

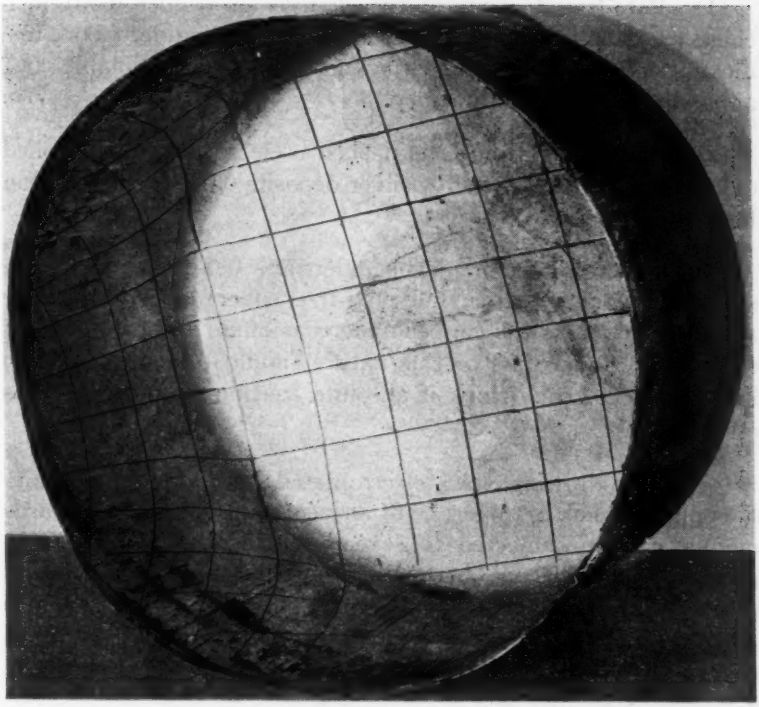
area of copper thus exposed would be too small to be of real consequence. Shells for cans and sheets for can ends have been plated with 0.001 inch of copper in a Rochelle salt-cyanide bath, followed by a silver strike and 0.0001 inch of silver from conventional silver cyanide baths. Tests on this material with ferroxyl gel containing both ferri and ferrocyanide showed that the deposits were pore-free. Since the component parts of the can are assembled after plating, there is no danger of cyanide being entrapped in crevices. Assembled cans packaged with beer and various fruit juices are now under observation. Although these cans are somewhat more costly than tin cans, they may be cheap enough to attract a quality market.

The barrel under develpoment is formed from two shells pressed out of plated sheet stock. Two approximately hemispherical shells are brazed together with a corrosion-resistant silver brazing alloy. The steel, similar to lot No. 1, is first plated with about 0.002 inch of copper from a Rochelle salt-bath, given a nickel strike from Wood's nickel bath, then a silver strike, and finally plated with about 0.001 inch of silver from a conventional silver cyanide bath. If the steel is properly cleaned and pickled before plating and is not allowed to dry between operations, and if the plating baths are carefully filtered to remove suspended solids, it is possible to produce consistently pore-free blanks. To date about seventy circles 2 feet in diameter have been plated and found to be pore-free, by flooding the plated circle with ferroxyl gel, a test which is especially severe. A silver-lined shell similar in size and shape to the half-barrels is shown in Figure 6 and the type of deformation involved is shown in Figure 7.

Forming tests made at the National Bureau of Standards and in a commercial plant have demonstrated that no difficulty is experienced in forming, by deep-drawing, sheets plated as described. Circles of steel plated with copper and silver, with silver alone, and with nickel and silver have also been pressed into shapes involving drastic plastic deformation without producing separation of the deposits. It is especially notable that with a total plating thickness of about 0.003 inch, press-forming operations did not perforate the coating.

When a steel forming die is used, the formed shapes may reveal superficial iron contamination. It is important that the forming dies be free from mill scale and defects that would lead to tool-marks and possible perforation of the coatings.

Where the component parts and fittings of the container are to be assembled by silver brazing, it has been found desirable to interpose a film of nickel between the copper and silver layers, as otherwise the heat of brazing produces the low-melting silver-copper eutectic alloy, and blistering of the coating results. Tests have demonstrated that with a suitable low-melting brazing alloy, and with proper care to avoid over-heating, joints can be made which are fully as strong as the steel without destroying the plated lining. If economically feasible, a more costly nickel undercoat could be used instead of the copper, or silver alone



might be used if the deposits were at least several thousandths of an inch thick.

Cans have also been formed from plated sheet by press-operations. For such work it appears that the total plating thickness should not be less than 0.002 inch if the basis metal is not to be exposed. Much depends on the finish of the die and on proper adjustment of the forming press. In this particular design, the bottom is attached by using a rolled lock-seam, and no solder is required. Such a can with an adequate thickness of silver should be useful as a small-capacity chemical shipping container of the returnable type.

6. CONCLUSIONS

With the conditions and basis metals used in this investigation, the following conclusions were reached:

(1) Pore-free deposits of either silver or copper 0.001 inch thick on deep-drawing steel are readily obtainable. Pore-free nickel deposits of the same thickness are also obtainable, but apparently with more difficulty.

(2) On a suitable basis metal, such as electroplated or polished oxygen-free copper, pore-free silver deposits 0.001 inch thick can be produced.

(3) Either copper or nickel undercoats 0.001 inch thick are suitable foundations for thin pore-free silver deposits, but for an equal thickness the copper undercoat offers a greater margin of safety. Undercoats of this nature should preferably be not less than 0.002 inch thick if absolute freedom from porosity is essential.

(4) Deep-drawing steel electroplated with ductile deposits of copper, nickel, or silver, or of any combination of these three metals, can be subjected to severe plastic deformation, as in press-forming, without perforating initially pore-free deposits that have a total thickness of at least 0.002 inch.

(5) No entirely satisfactory method has been found for determining the porosity of silver deposits less than 0.0001 inch thick.

(6) The hot water test is probably more dependable than any of the other methods, when the silver deposit is both thin and porous. For relatively thick silver deposits with low porosity, it does not make much difference which of the methods is used.

(7) The minimum thickness of deposit of silver, nickel, or copper that is required for pore-free coatings is dependent, other factors being constant, on the surface quality of the basis metal. The most homogeneous and smoothest surface requires the thinnest deposit. For the basis metals investigated, differences of this nature are of relatively little importance when the deposit is as thick as is necessary for industrial purposes.

(8) The minimum thickness of deposit of silver, nickel, or copper that is required for pore-free coatings depends on the freedom of the plating bath from suspended matter.

ACKNOWLEDGMENTS

The authors are indebted to the sponsors of the American Silver Producers' Research Project for making possible this work. They are also indebted to many individuals connected with the commercial companies that cooperated in the work outlined, to William Blum, of the National Bureau of Standards, and to S. V. Wilson and A. M. Setapen of the Silver Project staff, who assisted in metallurgical studies connected with the plating research.

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ADDENDUM

TYPICAL BATH COMPOSITIONS AND CONDITIONS

1. *Cathodic Cleaner*

	g./l.	oz./gal.
Trisodium phosphate	15	2.0
Sodium carbonate	15	2.0
Sodium metasilicate	7.5	1.0
Sodium hydroxide	3.8	0.5

Small amount of liquid soap
(approx. 0.1 cc./1 or 0.013 fl. oz./gal.)
Current density-20 amp./sq. ft.
Temperature-(95-100°C.)

2. *Acid pickle*

Hydrochloric acid (22Bé°)	180	24
Or	150 cc./1.	19.6 fl. oz./gal.

Temperature-Room temp. (23-27°C.)
Time-2 min.

3. *Copper Plating Bath, Rochelle Salt Type*

Cuprous cyanide (CuCN)	30	4.0
Sodium cyanide (NaCN)	38	5.0
Rochelle salts ($NaKC_4H_4O_6.4H_2O$)	45	6.0
Sodium carbonate (Na_2CO_3)	30	4.0

Current density-23 amp./sq.ft.
Temperature-(60-70°C.)
Agitation-moving cathode, overall velocity 5 ft./min
pH-12.2
(60 min. equivalent to approximately .001")

4. *Nickel Strike* (Wood's bath)

Nickel chloride ($NiCl_2.6H_2O$)	240	32
Hydrochloric acid (22Bé.)	145	19.5
Or	123 cc./l.	16 fl.oz./gal.

Current density-30 amp./sq.ft.
Temperature-room temperature (23-27°C.)
Agitation - none

5. *Silver Strike*

	g./l.	oz./gal.
Silver cyanide (AgCN)	6.5	0.9 (0.8 to. oz./gal.)
Potassium cyanide (KCN)	68	9.0

Current density-15 amp./sq. ft.
Time-10 seconds
Temperature-room temperature
Current should be on before plate is introduced.
Agitation - none

6. *Silver Plating Bath*

Silver cyanide (AgCN)	35	4.7	4.3 to. oz/gal.
Total potassium cyanide (KCN)	37	5.0	
Free potassium cyanide	19	2.5	
Potassium carbonate (KC_2O_3)	38	5.0	

Current density - 6 amp./sq.ft.
Temperature - room temp.
Agitation - moving cathode, overall velocity 5 ft./min.
Cathode efficiency approx. 100% (60 min. equivalent to 0.001")

7. *Nickel Plating Bath* (Watt's Bath)

Nickel sulphate ($NiSO_4.7H_2O$)	200	27
Nickel chloride ($NiCl_2.6H_2O$)	45	6
Boric Acid (H_3BO_3)	30	4

Current density - 25 amp./sq.ft.
Temperature - (38-42°C.)
Agitation - moving cathode, overall velocity 5 ft./min.
pH of solution - 5.3
One hour equivalent to .001"

8. *Composition of Ferroxyl gel used in testing for Porosity*

5 g. of potassium ferricyanide $K_3Fe(CN)_6$
0.5 g. of potassium ferrocyanide $K_4Fe(CN)_6$
10 g. of sodium chloride (NaCl)
5 g. of Agar
Distilled water to make one liter of solution.

A **Discussion** *of some of the* **Fundamentals** *of* **Electroplating Practice**

By W. L. PINNER

The following paper constitutes a part of the talk given by the author at the annual meeting of the Milwaukee Branch, April 29, 1939.

THIS paper does not have as its purpose the presentation of new ideas or new theories but rather to clarify, in a fairly non-technical fashion, certain principles involved in the constant duties of a plater. It is hoped that although only old principles are involved, that perhaps some new ideas concerning them will be gained as a result of this paper.

The following subjects are to be discussed:

1. How does one compute plate thickness from Farraday's law?
2. Why is it desirable, in low pH nickel baths to maintain a close pH control, especially since, below a certain value, pitting is rarely encountered?
3. What other factors must be considered to employ Farraday's laws to best practical advantage?
4. Why is such a low yield obtained in plating chromium as compared to nickel?

Certain automotive plate thickness specifications state that, "the nickel thickness shall be .001" which is equivalent to 20.8 grams per square foot." The relationship, referred to, between plate thickness and weight of nickel is arrived at as follows:

From handbook tables on properties of metals we learn that the specific gravity, or density, of nickel is 8.90. This means that a given volume of nickel weighs 8.90 times as much as the same volume of water. As a basis of computation, let us take a cubic inch of water, that is, a cube 1" x 1" x 1". Such a volume of water, by reference to a handbook, weighs 16.387 grams. It therefore follows that the same cubic inch of mass as nickel weighs 16.387 x 8.90 = 145.8 grams.

If, from this cubic inch of nickel a piece is sliced off which is

.001″ thick, this slice will weigh one-thousandth as much as the total, or 0.1458 grams. We thus have a mass of nickel 1″ x 1″ x .001″ with the above weight. Since there are 144 square inches in a square foot, then one square foot of nickel having a thickness of .001″ weighs 144 x .01458 equals 20.8 grams, the weight, as specified of a .001″ coating of nickel on a square foot of surface.

By similar means, and knowing their densities, the weight-thickness relationship of any other metal or alloy may be computed.

In arriving at the computations necessary to pre-determine the current and time required to deposit a given thickness of any metal, it is necessary to understand the laws developed by Farraday in the 19th century. For a concise discussion of these laws, the author recommends a recent article[1] by Dr. C. B. F. Young. Dr. Young states in part, "Faraday observed that if he passed, for example, one ampere for one hour through a copper sulfate solution, a definite amount of copper was deposited. If two amperes were passed through this solution for one hour, twice as much copper was deposited. By noting these and many other similar experiments, Faraday was able to express this as a theory which later became 'Faraday's First Law'. It may be stated thus: The quantity of metal dissolved at the anode or deposited at the cathode is dependent upon the time a given current flows. He found that a definite current flowing for a given time would deposit different metals in equivalent quantities. This is known as the second law of Faraday and may be stated as follows: The amounts of different metals dissolved at the anode or deposited at the cathode by the same quantity of electricity are proportional to their equivalent weights."

Principally based on experiments with silver, Faraday developed a basic fact, that 96,500 ampere seconds would deposit an equivalent weight of any metal. By equivalent weight is meant the ratio of atomic weight to valence of the metal involved. In the case of nickel from any ordinary sulfate bath, the equivalent weight is its atomic weight, or 58.69, divided by its valence, 2, or 29.34 grams. 96,500 ampere seconds, by conversion equals 1609 ampere minutes ($\frac{96500}{60} = 1609$) and this quantity of current will deposit 29.34 grams of nickel, according to Faraday's law.

Therefore, to deposit 20.8 grams of nickel, or a thickness of .001" on a square foot of surface, the ampere minutes required, by simple ratio is $\frac{20.8}{29.34} = 1150$ ampere minutes.

From Faraday's law, then, if 1150 ampere minutes be used for nickel deposition on a square foot of cathode surface, the thickness obtained should be .001". It should be mentioned that the 1150 ampere minutes per square foot may be 1150 amperes per square foot for one minute, or 1 ampere per square foot for 1150 minutes, or any part of either, the product of which equals 1150.

In the practical application of Faraday's law, if exactly the above quantity of electricity is used, the thickness obtained, or the weight of metal deposited will be somewhat less than that theoretically expected. However, if careful collection of all products at the cathode were made, it would be found that in addition to the nickel there will have been deposited hydrogen and possibly other metals if the bath were somewhat impure. The sum total of all cathode products, with their own particular equivalent weights would exactly conform to Faraday's law. The ratio of the amount of any metal actually deposited to that which should be deposited, according to Faraday's law, determines the current efficiency of the plating bath.

In nickel plating, the cathode current efficiency is generally over 90%, and the actual value is dependent on many factors. In a recent paper[2], Wesley showed a relationship existing between current efficiency and current density. Among other investigators, Pinner and Borchert[3] showed the effect of chloride on current efficiency, particularly in low pH baths. Bath composition, temperature and electrode size are among common variables which effect current efficiency.

Figure 1 shows the effect of pH in a Watts nickel solution on the resulting cathode current efficiency. It will be noted, for the particular bath in use, that the value of about 98% efficiency remains fairly constant at a pH above 2.9. At a pH of 2.0 the value is slightly under 95% and this drops off to 85% at pH 1.5. At a pH of 1.0, the efficiency is about 40%.

Due to this rapid drop with only a slight decrease in pH, a careful control of acidity in these ranges is necessary even though

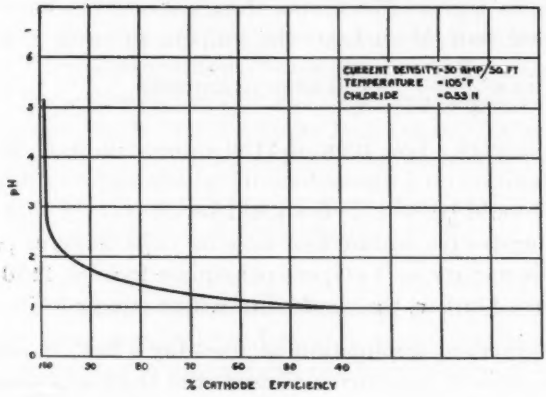

Fig. 1

hydrogen pitting is rarely encountered. It will be recalled that the pH range of from 3.0 to 4.5 has been called "no man's land" because, in this range, pitting is quite apt to be had. However, below a pH of 3.0, and more particularly below 2.0, with little concern for pitting, one needs to be careful of acidity if proper plate thickness is to be secured from a predetermined quantity of electricity, due to the pH-current efficiency relationship.

The co-deposition of hydrogen with the metal involved plays an important part in almost all cyanide plating baths. In the usual cyanide copper or cyanide zinc baths, for example, current efficiencies vary from about 20% to 60% for metal deposition with the balance represented almost wholly by hydrogen. The new high speed cyanide copper bath is a notable exception to the above where current efficiencies of approximately 100% are reported. There consequently is little or no hydrogen deposition from such a bath.

In chromium plating, cathode current efficiencies of from 11 to 13% are ordinarily obtained, the balance representing hydrogen deposition plus simple reduction of the hexavalent chromium to a lower valence. If one considers that the electrochemical equivalent of chromium is its atomic weight (52) divided by its valence (6) or 8.6 grams, and that deposition occurs at 13% efficiency, one can readily understand the relatively poor yield or chromium

per ampere minute. Thus, one compares nickel, for example, having an equivalent of 29.34 grams at close to 100% efficiency, against chromium whose equivalent is 8.6 grams, deposited at 13% efficiency. The actual value amounts to about 1.1 grams of chromium per 1609 ampere minutes.

It will be noted that Faraday's law states that, "the quantity of metal deposited at the cathode is dependent upon the time a given current flows." Similarly, as discussed above, plate thickness is determined by the time a given current flows to a given cathode area. The unit popularly employed to designate plate thickness is ampere minutes per square foot. Particular note should be made that the voltage employed to produce a given number of ampere minutes per square foot is incidental and is by no means a measure of the quantity of the plate deposited. Although voltage is necessary for the production of current, it is incorrect and meaningless to state that the quantity of plate is that produced by "plating 40 minutes at 5 volts". Dependent upon solution composition, temperature, electrode size, electrode spacing, electrical contact and many other things, "5 volts" may produce a current density which may vary from practically zero to an amount which will actually result in a burned plate. While it is desirable to know the voltage required for a given plating operation in order to design equipment and detect faults in a given set-up, the actual value is of no consequence in determining the actual plate applied. The actual weight, or thickness of plate can only be computed by knowing the time a given current flows coupled with a knowledge of the cathode current efficiency of the electrolyte in use, under the particular conditions in which it is being used.

All of the foregoing is of a technical nature, based on scientific fact, a knowledge of which is essential to intellingently compute plate thickness and anode usage. In order to apply this knowledge to practical plating, it is necessary to take into account throwing power and primary current distribution, so that the weight of metal being deposited may be properly distributed on the cathode surface involved.

It is not the purpose of this paper to consider throwing power per se, in great detail. The plater is well aware of the meaning of

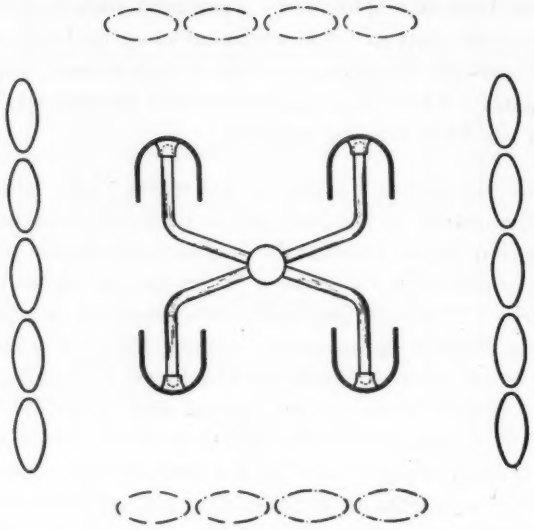

Fig. 2

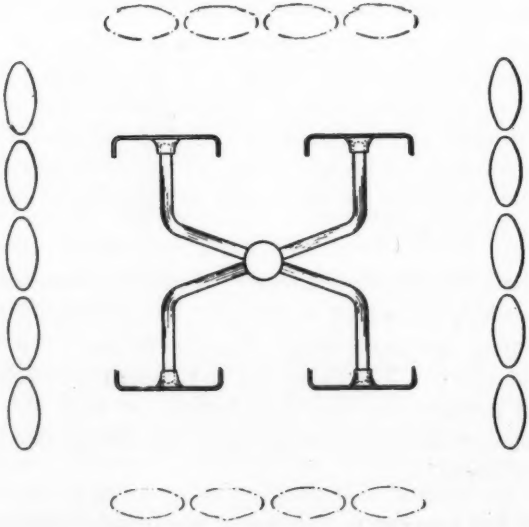

Fig. 3

this term and knows, for example, that the throwing power of a chromium bath is notoriously poor when compared with other baths.

The author does wish to stress and discuss the importance of a study of primary current distribution and, for this purpose presents figures 2, 3 and 4, representing racked parts during a plating operation.

In these figures, the articles portrayed may be any one of dozens of metals, stampings or castings. They may be hub caps, door handles, bumper guards, radiator grilles, pots or pans. Specifically, they represent formed metallic articles having an outside, significant surface to be plated to a thickness specification. The inside is not significant and, constituting the back, is not polished and is preferably not to be plated.

Figure 2 suggests an article having three significant surfaces and in which the linear dimension of the face is approximately equal to the dimensions of the two sides. The anodes, represented by the heavy lines are placed in a manner actually noted by the author in an otherwise well regulated plating plant.

With only a casual study of the set-up shown, several conditions will be seen to be incorrect. Bearing in mind that these pieces are being plated to a thickness specification, it is at once obvious that each of the four pieces will be plated to a certain thickness on the sides nearest the anodes. This thickness will prevail around a large part of the front of the piece and then diminish to a low value on the other side, opposite which there are no anodes. Obviously, if the rack be turned 90° from its present position, facing the dotted lined anodes as shown, better plate distribution will be obtained. The plate, dependent upon the actual size of the articles and the distance of the front of the pieces from the anodes should be fairly uniform, depending, in turn, upon the spacing of each piece to its neighbor.

With this spacing determined, and anode to cathode distance fixed, by plate thickness measurement, one other fault remains to be adjusted for sake of economy. The pieces should be moved more closely together, back to back, to prevent the waste of anodes on non-significant surfaces. In general, such pieces should be racked as closely together back to back as is physically possible to accomplish.

Figure 3 presents pieces, racked for plating which again may be any one of countless fabricated articles. In this case, the front dimension of the pieces is relatively large as compared to the side dimension. Again, the back is a surface not to be polished or plated upon. It is hardly possible that any well-informed plater would process the pieces in the position shown as regards the anodes and yet such practice would not be as ill-advised as the set-up originally shown in figure 2. In such position, the plate thickness on the front, constituting the most of the surface, if meeting the thickness requirement would leave only a small section over-plated and a small section under-plated.

Obviously, the proper set-up is that represented by the anodes shown as dotted lines and again one need be careful only of the spacing of each piece to its neighbor and, as before, the pieces should be moved closer together, back to back.

Figure 4 suggests pieces having the side dimensions large in comparision to the front dimension. Two pieces only are shown on one plating fixture. The author can conceive of no way to place four such pieces on one rack and obtain proper plate distribution with a normal anode to cathode distance. With only two pieces on one rack spline, the operator needs only to space the pieces properly with relation to its neighbor on the next spline to secure good plate distribution. Obviously, with the cathode dimension nar-

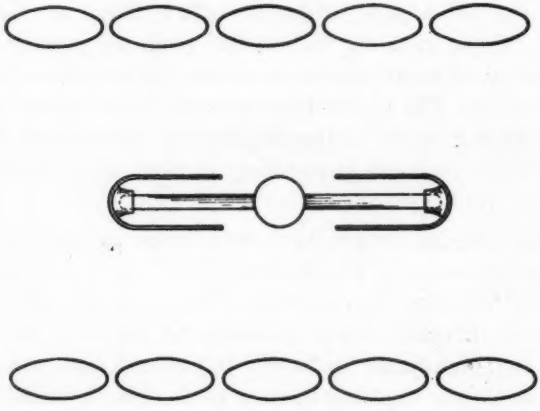

Fig. 4

row, an additional cathode compartment may be set up and utilized in a tank of any given width.

In the above illustrations, the articles shown consist of plain surfaces. Logically, deviation from plain surfaces into intricate design further complicates the picture. However, it is usually possible to classify articles in some one of the above three and employ the general principles outlined. Departure from plain surfaces involves the use of increased ingenuity and more careful examination of results obtained by plate thickness measurement.

In evaluating the results obtained, no better way can be employed than by microscopic examination of plate thickness over the entire surface under consideration. Particular attention should be paid to what should obviously be the heaviest and the lightest plated sections. Based on actual plate thickness measurements, every effort should be made to plate all significant surfaces as uniformly as possible. While the actual attainment of this ideal is substantially impossible, the closer to its realization that the job is brought, the more economical will become the cost of the plating operation.

The supplier of plated parts on a specification of thickness would do well to bear in mind that if he can "get away" with a thinly plated significant area on one part of a piece, that he might as well try and "get away" with thin plating on the entire piece. Such practice is becoming more and more rare and it is jointly due to the enforcement of specification by the user and to honest effort by the plating industry that deliberate thin plating bids fair to become unusual. The entire plating industry will benefit when such practices become absolutely obsolete.

On the other hand, if, on incorrectly racked parts, a sincere effort is made to meet specification on all surfaces, then other areas must be considerably over-plated to accomplish this. Such practice is expensive from the standpoint of excessive anode usage. The logical conclusion, then, must be to intensively study each individual part and process it properly for the sake of economy and of honesty to one's self and to one's customer. Any departure, within reason, from this policy must inevitably lead to waste and complaint.

Frequently, due to a peculiar shape of article being plated, a normal amount of surface area per rack or per tank may be found

to be impossible to attain. The operator of a plating plant should carefully consider all angles of so overloading tanks that overplating certain areas are necessary in order to just meet specification on other areas. For example, let us assume a nickel plating tank in which, normally, 50 square feet of cathode surface is processed for 1200 ampere minutes per square foot of plate. Let us assume for this a 40 minute plating time at 30 amperes per square foot for which is obtained a fairly uniform plate possessing a minimum thickness of .001″. Let us suppose now that articles to be plated are of such shape that in order to get 50 square feet in the tank it is found necessary to plate for 60 minutes at the same current density to get all surfaces plated to a minimum thickness of .001″. Logically, some surfaces will be plated in excess of .0015″, inasmuch as the average plate in this operation is .0015″. It might be economical to plate a smaller total area in the tank, effect good current distribution, and save the excess anodes. There may be additional labor or tank time, but these factors are not always the most expensive parts of a plating operation. Thus, in the above case, it might be better to process 30 square feet at a time and return to the correct basis of a 40 minute plate at 30 amperes per square foot. Any departure from this practice, in the assumed case, would mean either wasted anodes for correct plate, or incorrect plate on the low side and no means can be created to avoid either one or the other. The above assumes, of course, that a study of the possibilities of the part has been made and all ingenuity available has been exhausted by the plater in his effort to answer or improve the problem.

In the case of chromium plating, improper current distribution is usually easily seen in failure to obtain plate coverage. In nickel plating, this is seen only through a microscope or some similar means of measuring plating thickness. The author considers such a problem solved only through minute inspection for plate distribution coupled with practical changes in rack design and plating tank set-up as dictated by results obtained from such inspection.

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2. Nickel Plating from Chloride Solutions — Wesley, *Trans. The Electrochemical Society*, 1939.
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Here and There

CINCINNATI BRANCH The members of Cincinnnati Branch are so filled with enthusiasm that they don't want any summer time intermission. They want to meet each month the year around. Some "entoosmiasm" as Joe Adler says. O. T. Towner has consented to become Membership Chairman for another year.

We hear from Judson Elster of Rochester and George Simmons ot Herkimer, that Binghamton-Syracuse, Rochester, Buffalo and Toronto branches are planning a joint Picnic or Clambake in September. Looks like an International affair.

MILWAUKEE BRANCH We are sorry to learn that Robert Goodsell has resigned as Secretary of Milwaukee Branch. Robert has secured a position with the McDonald Mfg. Co. of Dubuque, Iowa. We wish him every success in his new field. He made a splendid Secretary and helped considerably in abstracting for the REVIEW. We still need you Bob, don't fail to write occasionally.

BRIDGEPORT BRANCH Outing, Saturday, September 9, at Eichorns Grove, Trumbull.

NEWARK BRANCH Outing at Vogel's Grove, Saturday, Sept. 30.

DAYTON BRANCH Dayton Branch will hold its regular meeting Sept. 8. Several members of the Executive Board will be present to help the Committee in their plans for the 1940 Convention.

PROVIDENCE-ATTLEBORO BRANCH Several of the members met recently at the Narragansett Hotel to plan for the Fall and Winter months. While it was agreed that Providence Branch membership could be greatly increased, the problem of the electroplater and the colorer seems to be the drawback. It was suggested that more papers on the coloring of metals, by dipping, would have a tendency to attract those engaged in this line of work, rather than too many papers on electroplating.

CLEVELAND BRANCH Mr. P. R. Lyons writes that Cleveland Branch has just had a most successful outing. The branch is planning a 25th birthday party in November.

SAN FRANCISCO BRANCH We have received very encouraging cards from the members regarding the future of the Branch. The Secretary, Mr. L. W. Miller of Oakland has sent us two checks which nearly cover last year's indebtedness. San Francisco Branch made a fine contribution to our Convention exhibits. We assure the members of our deep appreciation for this expression of their cooperation and good will.

HARTFORD BRANCH His many friends will be pleased to learn that Mr. Harry MacFayden of the Arrow Electric Company, who has been at home for several months recently, is recovering nicely and will be able to resume his duties shortly. The best wishes of friends in the A.E.S. are hereby expressed, for a speedy and complete recovery.

1940 Convention Dates

The following dates have been approved for the 1940 Convention:— June, 10-11-12-13, at the Hotel Dayton-Biltmore.

The above dates have the approval of the Executive Board.

COPIES OF THE CONVENTION PROCEEDINGS

The bound volumes of the papers read at the Asbury Park Convention in June will be ready for delivery to our branch Secretaries about September 1. We have increased the number of copies to each branch over the actual membership as of April 30, the end of the fiscal year.

The extra copies are to be given to members joining the various branches since June 1. We have made this provision at the request of many of our members, who feel it is only fair that we should do so.

Envelopes for mailing copies of the Proceedings to out of town members are also being supplied to each branch Secretary. Non-members of the Society can purchase copies at $5.00 each, which includes postage.

SIDELIGHTS OF DETROIT A.E.S. PICNIC HELD AT SANDY MAC'S
Saturday August 5, 1939

The fourth annual outing of the Detroit Branch, A.E.S., on the 5th of August was as usual a huge success in every way. The weather seemed to have been made especially for the occasion. Nice, sunny and warm, just enough breeze not to be windy. Everyone who attended enjoyed themselves immensely. There were quite a few out of town people present among them were our Supreme President Mr. Ray Goodsell of Racine, Wis., and the Supreme Executive Secretary, Mr. W. J. R. Kennedy of Springfield, Mass. Also some members of Toledo, Grand Rapids, Cleveland and Buffalo branches.

The attendance was approximately 225 with about 25 coming from the Society branches outside Detroit, Mose Cherry and his committee J. Hoefer, Dr. Saltonstall, W. L. Penner, Chas, Anger, and Ed. Berry and their able assistants planned the entertainment and contests, leaving no dull moments throughout the day. The program consisted of golf and horseshoes in the morning; lunch from 1 p. m. to 2.30 p. m.; games to 5 p. m. consisting of Kiddie Kar relay race, cigar smoking contest, Governors special pop drinking, egg throwing, and last but not least, the Annual Baseball game between the platers and their strippers. As to the baseball score the least said the better. However, both teams agreed that the umpires won the game, and so they walked off with the prizes for the winning team. The lunch consisted of the usual sweet corn, hot dogs, cold cuts and other refreshments. Just seeing the big kettle of hot sweet corn was enough to insure everybody getting in line several times for extra helpings.

The prizes for the winners of the various events and the drawing for the door prizes was the last thing on the program which kept the interest of those attending, for there were approximately 30 prizes given as awards and 20 gifts drawn as door prizes. All these gifts and prizes came from supply houses, and plating firms who cooperated 100% toward making the picnic a success.

THE HOT-NOSED REPORTER'S IMPRESSION OF DETROIT BRANCH A.E.S. PICNIC
Plater's Picnic — Huge Success

The annual picnic of the Detorit Branch of the American Electroplater's Society was held at the Sandy Mac's Golf Club Course, Saturday, August 5th.

The event was a high success being attended by over 200 members and friends of the local branch. Most of those attending enjoyed the golf which was free to everyone on the beautiful, sport 27 hole layout noted for its beautiful greens and glass-like fairways. Not many high scores were turned in as the course bears a reputation in the Detroit area as being one of the sportiest and toughest in this part of the counrty. Notable among the better golf scores was William Phillips of the General Motors Corporation with an 85 for the first nine; Carl Heussner just managed to beat Mr. Phillips with an 84 score — helped by several nudges in some of the cavernous traps. In as much as Jim Higgins threw away his card, no one can tell how he made out.

Supreme President Goodsell and Executive Secretary Kennedy were with us for the day and did the horse shoes fly through the air! They both won prizes — but not for pitching. The prizes must have been for working as Goodsell and Kennedy seemed to be among the busiest men present. It must have been serious business too, as they were always in a corner deep in discussion with Phillips, McCord or somebody like that. In the evening at the Yacht Club Kennedy took a drink. Don't get excited. It was only water. They both got away safely Sunday morning — we hope. We also hope they'll be back for our annual party, Dec. 9th.

Fred May of Electirc Auto-Lite of Toledo, took a lesson from Ed. Berry of the Udylite Corp., Mr. Cleve Nixon of Ternstedt and Paul Amundsen of Parker Wolverine decided to quit after three holes to give Cleve a chance to show the boys how to pitch horseshoes. Mr. Jack Bunch of Cadillac was a threat in the horseshoes pitching contest all the way.

Al Payson of the Michigan Buff Company and Joe Nook of Kalamazoo, entered a contest for which there was no prize. They both shot the bar in par. Jim Stewart of L. A. Darling Company, a Bronson socialite, brought a body-guard with him by the name of J. Wallingford Humphrey. He also brought two quarts of milk. How are your ulcers, Jim?

Phil Brockway of Ford Motors appeared in his usual sartorial splendor as a delegate from Esquire and walked off with the prize for being the best dressed man. Chester Marshall of Ainsworth won a prize in the Kitty-Kar race but next year Chester says, he will try something a little easier on the legs.

Some of the boys expected to spend the week-end at Sandy Mac's and the poker and dice games raged until the small hours.

Walter Pinner didn't help anybody's golf course by passing out advice and birdies through the loud speaker just when the boys were set to either tee off or putt.

Several father and son combinations were noticed on the grounds. William M. Phillips Sr., and Jr. seem to be inseparable all day, they played golf, pitched horseshoes and played table tennis. By my observations I would say that the Jr. is crowding Sr., in all the different sports and that it is a real Father and Son combination.

Other Father and Son combinations were R. C. Mahoney and Son; Herbert Cross and Son: and Ernie Beightol and Son.

A B. Wilson who is a past president of the Supreme Society and at present Chairman of the Research Committee was quite active all day taking part in all the Sports and Contests. He and Billy McCord and Paul Amundsen and Carl Kennedy had some croquet game. A tip to any one playing croquet with them is to surround the court with a high board fence.

Our President Jimmie Higgins of the Packard Motor Car Co. was quite busy in assisting the committee although it did not interfere with his getting rid of his share of corn and other refreshments.

Floyd Oplinger of Dupont de Nemours came all the way from Niagara Falls for this gathering and Mr. McDermid came from Waterbury, Conn.

We missed the presence of J. C. Robinson, Chas. Beaubien and Gus Soderberg.

We wonder how Paul Strausser got home after eating so much, and also when?

Orchids and plenty of them to Mose Cherry, General Chairman of the picnic committee and his able assistants Red Wilson, Charles Anger, Dick Saltonstall, Wright Wilson, Joe Hoefer and Walter Pinner. Our space is limited and we cannot express full gratitude to all the donors of the fine prizes which helped to make the affair a success.

Your hot nose reporters will now sign off with the hope that Carl Heussner either buy a pair of glasses so he can tell a ball from a strike or some day will get enough Coca-Cola.

ANDERSON BRANCH

The Anderson Branch of the American Electroplaters' Society held their regular dinner meeting at the Y.M.C.A. on July 11, 1939 at 6:30 P. M.

The evening was devoted to reports of the National Convention by Mr. R. M. Wagner and Dr. D. A. Cotton. Mr. Wagner gave a resumé of all the educational sessions and also the business meeting along with some of the other highlights of the Convention. Dr. Cotton then told of some of the things that were missed by Mr. Wagner including some of the plant visits made available to the delegates. Between the two the branch gained a pretty complete summary of the Convention. The Branch was disappointed that Mr. George Onksen could not attend and give his report on the Convention. Mr. Onksen is a former member of the Newark Branch and would probably have had many interesting things to tell.

The Anderson Branch wishes to congratulate the Newark Branch on a very fine Convention and wishes to thank them for the courtesy extended our delegates.

The Branch was honored with several guests including Mr. E. T. Ranson, Mr. Batist R. Haueisen and Mr. Miller of Indianapolis, Indiana and also Mr. Frank Rada and Mr. Walter Binai who applied for membership to the Branch.

The Branch received an invitation from Mr. E. T. Ranson of the Aluminum Finishing Corp. of Indianapolis to visit their plant. This was discussed and it was decided that the branch should accept the invitation and make the trip instead of holding a regular August meeting.

The Branch was very glad to welcome Mr. Elmer Unruh of Muncie, Ind., who transfered to the Anderson Branch from Dayton. It will be more convenient for Mr. Unruh to attend the meetings of the Anderson Branch.

OTTO W. MCCALLISTER, *Sec.-Treas.*

NEWARK BRANCH

The regular meeting of the Newark Branch of the A.E.S. held on Friday evening, July 21st 1939 at the Club Room of the Hotel Douglas. The meeting was called to order at 8:30 P. M. with President John Kotches presiding. All other officers were present.

The minutes of the previous meeting were read and approved.

The following applications were received and voted to take the regular course: Charles W. Wilson and Thomas J. Fadgen of Ternstedt Trenton Division, Trenton, N. J. to active membership.

Mr. Lloyd S. Burns of E. Reed Burns Mfg. Corp. was elected to associate membership.

Under reports of Special and Standing Committees, Mr. Horace Smith reported that the Convention at Asbury Park was a success in every respect and he was only sorry that all of the members of Newark Branch could not attend the Convention. He then called on Mr. Paul Oldam who told us how he managed to have a 100% Branch Exhibit. Mr. Smith then thanked all the Chairmen and Committee Members for their untiring

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assistance which made this convention a real success. He announced that a final and financial report would be ready for our September meeting.

Mr. Oliver Sizelove who spoke on behalf of his son announced that seven fishing boats have been engaged for our Annual Fishing Trip to Waretown, N. J. and that 37 members and their friends had made reservations so far.

It was next decided that Newark will hold an outing some time late in September or early in October. Horace Smith, Oliver Sizelove and George Wagner were appointed to investigate some of the picnic groves and make arrangements for this outing.

Upon motion duly made and seconded it was voted that Newark Branch shall hold their Annual Educational Session and Banquet either alone or in conjunction with New York Branch on the first Saturday after Easter Sunday in 1940. Mr. George Wagner was appointed Chairman with power to appoint his own committee.

Mr. Paul Oldam then told us in detail some of the interesting Exhibits he had seen in Rockefeller Center and at the New York World's Fair. He urged the members to visit the Exhibits he mentioned in-as-much as they were very educational.

Meeting adjourned at 10:15 P. M.

GEORGE WAGNER, *Sec'y.*

DAYTON BRANCH

At a meeting of Dayton Branch held on July 21, the following business was transacted:

1. The date selected for the 1940 Convention was the week of June 10-13.

2. The Dayton Biltmore was selected as the Convention hotel.

3. The following Committee Chairmen were appointed:

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Publicity:-Wm. Wise, 601 Oxford Ave., Dayton, Ohio.

Educational:-H. C. Luechauer, 19 Stockton Ave., Dayton, Ohio.

Program:-C. W. Powell, 321 Brooklyn Ave., Dayton, Ohio.

Banquet:-E. W. Cochran, 921 Rosedale Ave., Dayton, Ohio.

Registration:-Leon Haas, 64 Markison Ave., Columbus, Ohio.

Plant Visitation:-Fred Berner, N. C. R. Co., Dayton, Ohio.

Exhibits:-Lewis Smith, 618 McKaig Ave., Troy, Ohio.

Hotel Reservations:-Robert Skinner, 2603 Shafor Blvd., Dayton, Ohio.

Recreation:-Edison Sickman, 1248 Ray St., Dayton, Ohio.

Transportation:-Clarence Folz, 1009 Haynes St., Dayton, Ohio.

Secretary:-C. W. Powell, 321 Brooklyn Ave., Dayton, Ohio.

Treasurer:-Wm. Durnbaugh, R. R. #4, Xenia, Ohio.

CHAS. C. CONLEY, *President.*

PHILADELPHIA BRANCH

The Philadelphia Branch Board of Officers meeting was called to order by President J. E. Underwood. Roll Call of Officers showed all present.

Applications of K. McMillen for Active and J. E. Button, R. E. Slay and H. L. Hovis for Associate Membership read. Moved and seconded applications be referred to Board of Managers was carried. Application of George T. McLintock for Active Membership reported on favorably by Board of Managers and Mr. McLintock was elected an Active Member of the Branch.

Transfer of Mr. L. B. Doll, Active Member of Chicago Branch to Philadelphia accepted. Request for transfer by Mr. Writer from Philadelphia Branch to Chicago Branch complied with. Communication from Walter C. Gold read and laid over until next meeting.

Branch notified of the death of Mr. H. Snyder on July 20, 1939. Moved and seconded letter of condolence be sent deceased family was carried.

Bill read for per capita tax - same to be paid if found correct by Board of Managers.

Lancaster Committee, Chairman Critchfield reported progress. Dr. A. K. Grahan will deliver a talk on "Cyanide Spotting Out."

During a very earnest discussion on Publication and Awards, it was moved and seconded that a committee be appointed to draw a resolution for adoption to the Constitution of a Publication Committee. The motion was carried and Mr. L. A. Critchfield appointed chairman of the committee.

Secretary then reported having received the A.E.S. buttons and same are for sale to members at forty cents each.

Communication from Third Supreme Vice President Mr. Nelson Sievering regarding Branch Chairman for Membership Drive read. President Underwood appointing Robert E. Jackson, Jr. Chairman.

Moved and seconded a meeting be held on August 24th, 1939 at 8:00 P. M. at Mr. George Gehling's was carried. There being no further business meeting was adjourned.

ROBERT E. JACKSON, JR., *Sec.-Treas.*

LOS ANGELES BRANCH

The Los Angeles Branch of the A.E.S., held their regular monthly meeting on Wednesday June 14, 1939 at the Rosslyn Hotel.

President Ray Bray called the meeting to order at 8 P. M. Minutes and Financial report of the previous meeting were read and accepted.

Mr. Barney A. Lebb and Mr. Joe Spallino were elected members of the Los Angeles Branch.

Mr. M. D. Rynkofs discussed a detailed blue print for building insulated racks for the exposure tests to be conducted on the Pacific Coast, and stated that some time in July a special meeting would be called to discuss ways and means of financing the building of these racks.

The meeting was then turned over to the Librarian, Mr. E. R. Holman, and that much discussed topic "Wetting Agents" was delved into for the next ninety minutes.

Meeting adjourned at 11 P. M.

RAYMOND SOLIVAN, *Sec.-Treas.*

CHICAGO BRANCH

The regular monthly meeting of the Chicago Branch was held on July 8, 1939. Vice President E. A. Lanz presiding and all other officers present.

Mr. R. B. Eyre and S. Lupescu were elected to membership.

Mr. H. A. Gilbertson and Mr. F. J. Hanlon gave a complete report of the convention citing in detail each paper and all other activities of the four days in Asbury Park, N. J.

The following question was in the question box.

Q. What causes tin from a stannate bath to plate dark and powdery?

A. Too high in caustic or too much tin in the stannate condition.

M. H. LONGFIELD, *Sec.*

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CLEVELAND BRANCH

The regular meeting of the Cleveland Branch was held in the Empire Room of the Hotel Cleveland, Saturday night, August 5th, with Vice President Carlson in the chair.

An application for Active Membership was recieved from Mr. Richard Morrow, owner of the Ashtabula Chrome Plating Co.

Mr. C. B. Potter, of the Potter Cleveland Supply Co. and Mr. Harold Trambicki, of the Cowles Detergent Co. were elected as Associate Members.

The Picnic Committee, consisting of Mr. O'Berg, Chairman, Mr. Singler and and Mr. Binder, made their final report and were warmly thanked by the Branch for the fine affair they provided at a very nominal cost. When a committee gets out and produces good weather, good events and good refreshments, there

isn't much left to be asked for. It was suggested that they be given this job permanently.

Chairman Scott, of the Silver Jubilee Committee, ably helped by Mr. Singler, gave a report on the progress made toward our 25th Birthday Party next November. By the time Bill and Joe got through talking about food, floor show, noise makers, balloons, etc. etc., they had the whole meeting on its feet with its mouth watering. It looks as though things will be bigger and better.

The list of members subject to being dropped for non-payment of dues, having shrunk to only six, it was the sense of the meeting that these six be given another month to make known their intentions toward getting back into good standing.

As our next meetings falls on Labor Day week end, it was decided to advance the date from September 2nd to September 9th.

Mr. R. O. Hull made a more detailed announcement of the course for Electroplaters that he is to teach at John Huntington Polytechnical Institute this fall. The registration for this course will take place during the week of September 18th. A fee of $5.00 will be required from each registrant. This fee will be returned to those who attend 80% of the term.

As Librarian Truden has accepted a position out of town President Matts has selected Mr. R. O. Hull to serve out the unexpired term. The Branch is to be congratulated on having such a talented man eccept this responsibility.

Mr. Hull introduced Mr. J. F. Sieffen as the speaker of the evening, who talked on the subject: "Abrasive Bond". Mr. Sieffen handled his subject with a skill that demonstrated his knowledge of polishing. The interest he created was evidenced by the fact that after the meeting was adjourned, a group of "Shiners" continued the discussion with him. Mr. Sieffen was accorded a rising vote of thanks.

Meeting adjourned at 10:20 P. M.

P. R. LYONS, *Sec.*

CINCINNATI BRANCH

A special meeting of the Cincinnati Branch of the A.E.S. was held Thursday, July 27th, 1939, at the Hotel Metropole with Robert Knoepfler, presiding. The minutes of the previous meeting were approved as read.

A request by Mr. Harry Misner for active membership in the Cincinnati Branch, A.E.S. from the Dayton Branch was granted.

A vote was taken as to whether or not a meeting should be held in July

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0.9—1.5 (copper, etc.)	silver)
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and August of next year. This was done so that the Board of Managers could arrange their program for the next year.

One of our members, Mr. Bode, brought several gold plated samples with him to our meeting. They were passed around for inspection and were very interesting. He offered to tell us more about them at our August meeting.

In order to promote interest at our meetings and increase our knowledge, Mr. Daymude consented to give us some information on short cuts in the analysis of tin-plating solutions and cadmium plating solutions. The subject for August will be tin-plating solutions and for September the subject will be Cadmium solutions. Our Membership Chairman, Mr. Towner, was given permission to use any of the information given in these talks in his drive for new members.

MARTIN GANNON, JR. *Rec-Sec.*

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MONTREAL BRANCH

The Montreal Branch of the A.E.S., held its regular monthly meeting on July 6th at the New Carlton Hotel.

President Charles Doherty called the meeting to order at 8.30 P.M., the roll call showed fair attendance despite the sweltering heat.

Minutes of last meeting were read and adopted, and the usual routine business attended to.

Messrs Chas. Douglas, E. Creighton and J. Rissenburg of the membership committee report on preparations for autumn program to increase membership, and it is certain that this trio will convince many of the eligible prospects that the A.E.S. is an open door inside which can be had the answer to many difficult plating problems.

The election of Mr. J. H. Feeley to Honorary membership in the Supreme Society was greeted here with much enthusiasm and sincere applause. Mr. Feeley is our own champion and all who have had association with him will agree that he is worthy of this honor.

Montreal, though defeated in its effort to bring the convention here in 1940, voted hearty congratulations to Dayton Branch and its members, wishing them every success and that theirs will be a memorable event.

Mr. H. S. Jordan, librarian and chairman of educational work, disposed of all questions in a manner which indicates that here is an interpretor of chemical equations and formulas that will keep the question box a target for many technical problems.

Meeting adjourned at 11 P. M.

A. W. JEROME, *Sec.*

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HANSON-VAN WINKLE-MUNNING COMPANY STAFF CHANGES

Charles L. Anger has joined the sales staff of the Hanson-Van Winkle-Munning Co., Matawan, N. J., manufacturers of electroplating equipment and supplies. He will be located in their Detroit office, 2842 W. Grand Blvd.

Carl F. Miller & Co., Inc., 1033 — 6th Ave. South, Seattle, Wash., have been appointed distributors for the state of Washington, for the Hanson-Van Winkle-Munning Co., Matawan, N. J., manufacturers of electroplating equipment and supplies.

John A. Bauer, who has been for several years in charge of the New York office of the Hanson-Van Winkle-Munning Co. of Matawan, N. J., manufacturers of electroplating equipment and supplies, has been transferred to Matawan, N. J., to assist L. M. Hague, Vice President in charge of sales. Irving A. Gemmell has been taken from the Engineering Department at Matawan and placed in the New York office.

RECTIFIERS FOR ELECTROPLATING AND ELECTROTYPING

Bulletin ER-102, issued by the Hanson-Van Winkle-Munning Co., Matawan, N. J., manufacturers of electroplating equipment and supplies, is the first complete detailed treatise on this new type of equipment for producing low-voltage, direct current for electrodeposition. It describes the principle of copper-oxide rectification, the construction of the complete rectifier, its operating characteristics, its applications and advantages. A few representative testimonials are given from users of rectifiers.

The Bulletin is profusely illustrated by means of electrotypes made with H-VW-M copper-oxide plate-type rectifiers.

Grinding Wheel Fatality

California reports its first fatality in over a year from an exploding grinding wheel. There was no hood on the wheel at the time of the accident but the general safety orders of the State's Industrial Accident Commission require that hood guards be attached wherever it is practical.

Where hoods are not possible, protective flanges are indicated. Specifications for such flanges are given in the Safety Code for the Use, Care and Protection of Abrasive Wheels, published by the American Standards Association. *Hazards and Safety*, August 1939.

The J. B. Ford Sales Co. of Wyandotte, Mich. have published an attractive tabloid newspaper entitled "Wyandotte at the Fairs". It's yours for the asking.

News Item

The Lea Mfg. Co. of Waterbury, Conn., manufacturers of Lea Compound and Learok, polishing and buffing compounds, announces the appointment of William D. Starr to its research staff. Mr. Starr, Yale '27, was formerly manager of the Eastern Engineering Co. of New Haven.

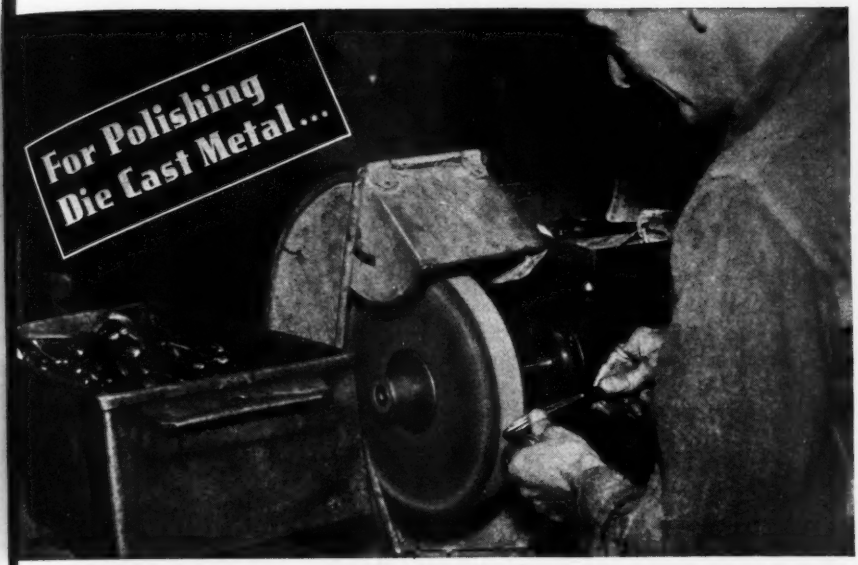
Henry Snyder

Mr. Henry Snyder, Vice President of Rossberg and Snyder, Inc., Job Electroplaters of Philadelphia, Pa. died Thursday July 20, 1939 at his home 3942 N. Marshall St., Philadelphia, Pa. He was 63 years old.

Mr. Snyder was an Electroplater and Specialist in the field of Metal Finishing.

He was a Past President of the A.E.S., Philadelphia Branch. For the past ten years he was a valuable assistant in teaching the Electroplaters the chemistry of their business at the Jules Mastbaum Evening School, Philadelphia, Pa.

He is survived by his widow Anna, two sons and four daughters. He was buried in Holy Sepulchre Cemetery in Philadelphia.



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The Abstract Section

FREDERICK FULFORTH, *Chairman, Program and Educational Committee*

Electroplating on Rustless Steel. By G. BUSS. *Mitt. Forsch-Inst. Probieramts Edelmetalle staatl. höheren Fachschule schwäb. Gmünd* **12,** 83-91 (1938), 98-105 (1939). Electrolytic deposition on rustless steels offers the same difficulties as on chromium and passive nickel. The deposits do not adhere and they spall because of the oxide film. Efforts were made to remove the film and other difficulties in order to obtain satisfactory deposits. Good silver deposits were obtained by first pickling in HCl solutions of by anodic pickling and then undercoating with iron or zinc from acid baths (for 1-3 minutes); the article was then silver plated in the usual manner.

An undercoat of copper of good adhesion could be obtained by first dipping the steel in a solution containing 150 g. HCl and 1-5 g. CuCle per liter. After 45-90 seconds a firmly adherent copper film formed. Increase of temperature of the solution up to 175°F. shifted the range of precipitation of the film to lower acid concentrations and reduced adhesion. Additions of chromium, manganese, and iron did not improve the copper deposit except 10 g. manganese per liter, which after one minute produced a good bright copper film. It was, however, better to deposit the copper film electrolytically from a 50% HCl solution containing 2 g. $CuCl_2$ and about 20 g. NaCl per liter. Voltage was 1.5-2 v., c.d. 4.5-14 amps./sq.ft. for 0.5-1.5 minutes.

The silver deposit had to be absolutely dense and free of pores. If not, corrosion of the basis metal took place even under the action of substances which do not attack the Cr-Mn steel itself. This is due to the formation of local couples. A table shows the potential differences of Cr-Mn steel against pure silver in 5% solutions of sodium chloride, acetic acid, lactic acid, sulfuric acid, and 1% lactic acid + 0.2% sodium chloride. Twelver references.

M. HARTENHEIM

Chemical Abstracts **33,** 4133 (1939).

The Rate of Decomposition of Hydrogen Peroxide in Nickel Sulfate Plating Baths. By GERALD U. GREENE. *Trans. Eelctrochemical Society* (Preprint 76-1) 1939. In nickel plating baths, high temperatures or high pH cause more rapid decompoistion of hydrogen peroxide added as an anti-pitting agent. The decomposition is not much affected by the amount of peroxide added, nor by the type of anode used unless it contains a large amount of iron as the 95-97% anode. Nickel hydrate and ferric hydrate are catalysts. Hydrogen peroxide added before filtering is apt to be decomposed in the filter. Anode bags retard the decomposition occuring at the anode surfaces.

ERNEST H. LYONS, Jr.

Lead Anodes in the Electrolysis of Zinc. By LIVIO CAMBI and ROBERTO PIONTELLI. *Chimica e industria* (Italy **20,**) 649-57 (1938). The results of Rey, Coheur and Herbiet (see *Chemical Abstracts* **32,** 3270) show that

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THE McGEAN CHEMICAL COMPANY
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at a current density less than 2 amp./sq.ft. cathodic contamination is due mainly to lead sulfate passing into solution. Cambi and Piontelli confirm this view, but maintain that at higher current densities, the dispersion of PbO_2 is the predominating factor. An electrode of lead-silver (containing 0.96% silver) gives zinc of higher purity than either a lead of a PbO_2 electrode.

A. W. CINTIERI
Chemical Abstracts
33, 2042 (1939)

1. Barrel Finishing of Metal Products. H. LEROY BEAVER. *Product Finishing*, May 1939, pp. 18-27. Another discusses several current sources of troubles met with on trip. One commonly met was rust pitting of burnishing balls. Caused by letting stand overnight without being covered by water. Repeated rusting causes pits which do not look bad to naked eye, but with which satisfactory finish cannot be obtained. Spots are "cleaned" by washing in kerosene to remove stain, but this still leaves rough pitted surface. Remedy is to have balls refinished, which involves a cutting down operation and burnishing. This is best done by manufacturer. A frequent source of pits is waiting for 2 or 3 days before cleaning up around barrel. Parts are rusted and should not be used with good balls. Rusted balls may sometimes be recovered by burnishing with 1½% of Vienna Lime per gallon of water for 24 hours. Rust should not be confused with dull scum of lime soap which may form from hard water may be removed with 3% Tetra sodium pyrophosphate.

Linings for burnishing barrels are discussed. Sappy yellow pine may be used instead of hard maple, but should be cleaned in 4% Caustic before using.

Author also emphasizes need for using full amount of balls, as burnishing is a pressure effect. Burnishing efficiency will be lost if barrel is underloaded.

PHIL J. RITZENTHALER

2. Use of Conveyors Expedites Production in Plating Department. By E. W. COCHRAN. *Product Finishing*, June 1939, pp. 16-24. Describes conveyors and procedure used at National Cash Register Co., two types used, a belt conveyor overhead and an overhead trolley. In polishing room this is especially useful as it eliminates work storage problem. Work must be of a type and continuous enough to justify conveyor system. Descrites polishing procedure, bright nickel and chromium plating.

PHIL J. RITZENTHALER

METALS AND ALLOYS ABSTRACTS

3. Notes on Routine Testing of Tinplate. W. E. HOARE. *Sheet Metal Ind.* Vol. **13,** Feb. 1939, pp. 227-8 Tests for porosity of tin on steel. (a) Loss in wt. of specimen after 24 hrs. exposure to solvent of $\frac{N}{200}$ HCl plus 15 ppm SO_2 at 32°C. This medium attacks Fe in preference to Su. (b.) Electrolytic sulfide treatment: S_2 plate is made anode with aC Cathode in solution of NaHS at 1-2 amps/1 dec^3 and 5-10 volts. After 10 minutes normal and potential cores as well as unevenness of coating are visible. Test may be made quantitative by running it longer and determining sulfide.

BETTER DEPOSITS
FEWER REJECTS
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Hydrogen evalution method determines the time to evalue 5cc hydrogen in NHCl. Correlation in service shows definitely that porosity is related to thickness of coating and hence to service life. PHIL J. RITZENTHALER

4. Piston Ring Treatments. H. MUNDORFF. *Automobietechmik* N Vol. **42,** Feb. 1939. In order to cut down piston ring wear, following treatments are used; (a) Coating rings with Su (b) Phosphate treatment. This forns thin porous film which holds oil and reduces wear. (c) Transformation of surface into oxide of iron (ferrox process). This coat acts as polishing agent on cylinder, eases running in and reduces danger of seizing may have other friction applications. PHIL J. RITZENTHALER

Hints for Platers. By A. DARLAY, *Galvano* (Paris) March 1939. 1. *Electrolytic Degreasing.* The sheet iron tank containing the cleaner is seldom properly insulated. Sheets or reinforced glass along the sides are inexpensive and effective. Use of tank walls as anode is very poor practice.

Films left from inadequate cleaning may often be detected by milky spots showing on work upon immersion in clear water after cleaning. The acid rinse needs replacing if iridescent spots show on work when exposed to air after rinse, but do not show on work not given same rinse. Trouble here may be due to acid used.

Lack of adherence of nickel on copper has been traced in several cases to presence of fats in polishing compounds which the degreasing bath cannot clean. Such fats may occur in inferior grades of compounds. A degreasing operation is not sufficient cleaning on polished work coming from vapor degreasing.

The English practice of rinsing under pressure jets is recommended. The leaving of work suspended in water before nickeling is not.

Large additions of cyanide to a cleaner should not be made as excess of cyanide is a frequent fault. C. T. THOMAS

New Patents. **Surface Treatment of Cadmium and Cadmium Plated Articles; Electroplating.** By PRISTON, H. R. and CLARKE, S. G. *The Metal Industry*, London, England. Volume **LIV,** No. 26, June 30, 1939. The formation of spots or discolored areas on the surfaces of cadmium or cadmium plated articles is prevented by immersing the articles in a plain solution of chromic acid or a soluble chromate or dichromate. The article may be cleaned, dried by dipping in acetone and exposing to warm air, and then immersed for about 15 minutes in a 5 per cent solution of chromic acid, chromate or dichromate. For cadmium plated articles the immersion is normally effected directly after plating and washing. The treated articles are washed and then preferably rinsed in distilled water and dried rapidly; they may then be lacquered. ROBERT B. GOODSELL

Aluminum Coating of Aluminum-Behavior of Alloy Constituents. By F. KELLER, G. W. WILCOX, M. TOSTERUD, and J. C. SLUNDER. *Metals and Alloys*, July 1939, Page 219. The properties of anodized aluminum, viz. resistance to abrasion and corrosion, and pleasing appearance obtainable

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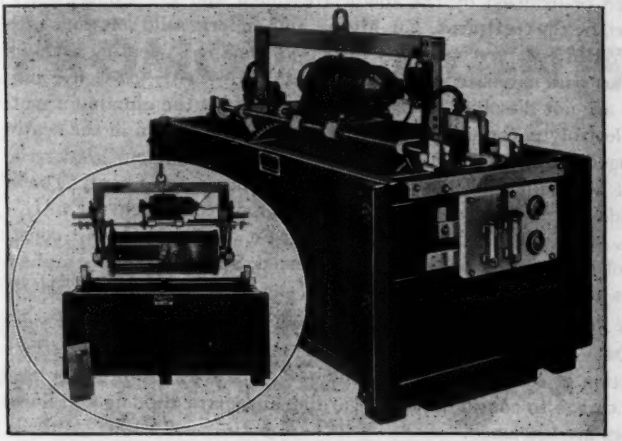

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with other protective and decorative films, has lead to many new uses during recent years. A series of extensive tests has shown that the presence of alloying constituents has a marked effect on the properties of the anodically coated metal. Microscopic examination of different anodized alloys have revealed that the various alloying constituents may be grouped under three classifications: (1) Alloying constituents in solid solution, (2) Constituents not appreciably dissolved or oxidized by the anodic treatment and (3) Constituents readily dissolved by the treatment. Cu, Mg, Si, and Zn form solid solutions with aluminum. When they are uniformly dispersed the anodic coating is uniform and resembles pure anodized aluminum. Si, Al-Mn, $CrAl_7$, Al-Cr-Fe and Al-Cu-Fe-Mn are not dissolved or oxidized as rapidly as the aluminum matrix in a CrO_3 electrolyte, therefore these constituents will remain in the coating in an unchanged condition. Silicon furnishes the best example of a material which will not noticeably dissolve or oxidize by the anodic treatment. The following materials are readily dissolved by the anodic treatment: $CuAl_2$, $_bAlMg$, $MgZn_2$, Al-Cu-Mg, $_aAl$-Cu-Fe, $_bAl$-Cu-Fe, and Al-Cu-Ni constituents. Table of composition of the 18 alloys tested, and photomicrographs of cross sections are also shown. D. S. HARTSHORN, JR.

How Should the Finish Be Applied? By E. A. ZAHN *Products Finishing* May 1939. The author gives some excellent practical suggestions on the application of coatings to metal products. The selection of spray equipment and its care, also considerations regarding automatic dipping and flow-coating processes are discussed. E. LACY

Use of Conveyors Expedites Production in Plating Department. By E. W. COCHRANE. *Products Finishing*, June 1939. This is a general discussion of the value and uses of automatic handling of parts in the finishing department, with special reference to its application in the plant ot the National Cash Register Company at Dayton, Ohio.

The article is well illustrated and the sequences of operations for Nickel and Chromium plated parts clearly described. E. LACY

Barrel Finishing of Metal Products. By H. LEROY BEAVER. *Products Finishing*, June and July 1939. These articles deal particularly with current practice in the barrel finishing of plastics. The necessary procedure differs materially from that required for metal products. Instead of steel balls and soap solution, various preparations of maple wood fibre etc, depending upon the type of plastic material being finished are used as abrasives. Details ot procedure and equipment are clearly described and those confronted with this type of problem would do well to read these articles. E. LACY

Note on the Stannous Ammonium Oxalate Electroplating Bath. A. W. HOTHERSALL and W. N. BRADSHAW. *J. Electrodepositors Soc.*, 15, (preprint) 4 pp. (1939). The stannous ammonium oxalate bath was less satisfactory than the stannous sulfate bath, because satisfactory deposits were obtained over a narrow range of current density, namely 2.5 to 5 amp./ ft^2. The composition of the bath was stannous oxalate, 6.7 oz/gal.; ammonium oxalate, 8 oz/gal.; oxalic acid, 2.0 oz/gal.; gelatin, 2.7 oz./gal. The bath was stable at a pH below 4.0. Above a pH of 4.2 a precipitate formed on standing. The cathode current efficiency was 99%. A. BRENNER

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Copper Refining. R. D. BURN. *J. Electrodepositors Tech. Soc.*, **14,** 169-82 (1938). The Cu refinery at the Ontario Refining Co., Copper Cliff, North Ontario, is described. Blister Cu is melted in reverberatory furnaces having a capacity of 350 tons per day. The metal is transferred in a molten state by a car (capacity 60 tons) to the refinery, 1.25 miles away, where it is subjected to fire-refining and then cast into anodes. The tank house contains 1,230 tanks which are lined with antimonial lead. The electrolyte contains 3% Cu and 13% free acid and is heated to 150°F. The c.d. of deposition is 15 amp/.ft^3. There are two electrical circuits in the tank house, each having a voltage of 120-150 and carrying a current of 11,000 amp. An electric direct arc furnace is used for melting the refined cathodes preparatory to casting. A certain proportion of the electrolyte is bled off each day from segregating tanks of the Pyne-Green type and purified. Ni salts are obtained as a by-product from this electrolyte. Slimes are removed from tanks every 28 days. Ag is obtained from the slimes by electrorefining, and Au and Pt are recovered from the slimes left in the silver refining. Se and Te are recovered partly from slimes and partly from flue gases. The author also discusses the electroforming of Cu sheet and tubing and bimetallic Ni-Cu sheet. A. BRENNER

The Anodic Solution of Alloys. By F. R. MORRAL and J. L. BRAY. *Trans. Electrochem. Soc.* (Preprint 75-6) 1939. In a search for a material to withstand anodic currents in electropickling, the anodic corrosion of twelve metals and fifty-six alloys in 15 to 2;% sulfuric acid was studied at current densities up to several hundred amps./sq.ft., and in a few cases as high as 2650 amps./sq. ft. The most resistant metals were lead, tellurium lead, and and iron alloys containing 14% silicon or 25% titanium. Data are also reported: chrome, stainless, and high speed steels, nickel alloys, carbides, etc. ERNEST H. LYONS, JR.

Electrodeposition of Various Metals Upon Zinc Alloy Die-Castings. A. W. WALLBANK. *J. Electrodepositors Tech. Soc.*, **15,** (preprint) 10 pp. (1939). The design and preparation of the castings are important. Sharply angled recesses or projections should be avoided. In casting, the temperature of the alloy should not exceed 850°F. A typical alloy is Al, 4.10%, Cu, 1.00%; Mg, 0.03%; balance, Zn of 99.99+ % purity. Tin, Pb, or Cd must be absent as they cause intergranular corrosion. The castings have a dense outer skin about 0.01 in. thick which should not be cut through during polishing, as the metal underneath may be porous. However, some castings develop blisters during plating, because of a failure in the extreme outer layer of the surface skin. Such castings must be well polished. The die castings are cleaned preparatory to plating by degreasing in trichlorethylene and then electrocleaning in a bath of sodium metasilicate and trisodium phosphate, to which wetting agents may be added. The time of immersion in the cleaner should be about 30 sec. and never exceed 2 min. Two plating procedures are described: (1) direct Ni plating from a high sulfate Ni bath and (2) the production of Cu-Ni composite coatings by first Cu plating in a CuCn-Rochelle salt bath and then bright Ni plating. A. BRENNER

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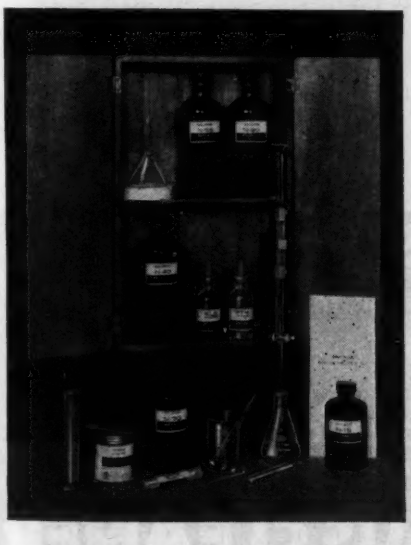

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